

November 17, 2016

Ms. Julia Wellman
Environmental Impact Review Coordinator
Virginia Department of Environmental Quality
629 E Main Street
Richmond, VA 23219

Re: Mountain Valley Pipeline's Response to the Virginia Department of Environmental Quality's October 27, 2016 Request for Additional Information

Dear Ms. Wellman:

Please see Mountain Valley Pipeline, LLC's (MVP) following response to the Virginia Department of Environmental Quality's (DEQ) request for additional information on October 27, 2016. This information request is based on the Federal Energy Regulatory Commission's (FERC) Draft Environmental Impact Statement issued on September 16, 2016. MVP's response is as follows:

COMMENT 1: Any additional detailed karst information developed from karst surveying at sites which were not accessible during development of the report.

RESPONSE 1: Please see the updated Karst Hazard Assessment (Attachment 1), that includes additional field survey information (pages 1 -60), in the flash drive device provided by MVP. This updated document was filed with FERC on October 13, 2016.

COMMENT 2: Fracture trace analysis (DR3 General 3) that used LIDAR referenced in the October 2016 Karst Hazards Assessment Report

RESPONSE 2: Please see the updated fracture trace analysis with additional information in **Attachment 2**: Fracture Trace Analysis, pages 1-3 respectively. This updated information was filed with FERC on October 13, 2016.

COMMENT 3: Responses to the following questions regarding the Water Resources Identification and Testing Plan (page 41-78):

COMMENT 3(a): What is the purpose of the baseline water resource testing program? Presumably to determine or refute later complaints of impact from the construction activities, but it would be good [to] spell out why they are testing water quality and how it will be used.

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RESPONSE 3(a): The pre-construction baseline water resource testing program was developed to characterize groundwater resources including springs, and public drinking water supplies, near the proposed MVP alignment and related construction areas. The program includes: (1) accurately locating a water well, spring or public surface water intake; (2) gathering information about the use and physical condition of the water resource; and (3) collecting pre-construction water samples for analysis to establish the properties of the water. Because both quality and quantity of groundwater (including springs) and drinking water resources are seasonally influenced, pre-construction samples have and will continue to be collected in characteristically dry and wet seasons to account for natural variabilities.

Water testing and sampling results of drinking water supplies will be provided to the relevant property owners. If the pre-construction testing indicates that a private water supply is compromised, MVP will consult with the owner about the results so that they may take appropriate action. In our experience, residents relying on private wells in some cases may be unware of existing problems with their drinking water. Those preexisting problems may not be discovered until after construction is complete, and there is a potential for such problems to be incorrectly attributed to the construction activities. Identifying those issues in advance provides a beneficial service to nearby landowners. While construction activities are not expected to have an adverse impact on any water resources, this baseline information will establish the pre-construction condition and quality of a groundwater and drinking water supply, should any concerns arise post-construction, regarding potential impacts to water supply quality or quantity.

COMMENT 3(b): Will springs within 500 ft of the pipeline work areas that are on property without a building also be sampled (ie. all springs within 500 ft of pipeline or just ones that are on property with a structure as discussed in section 5.2, page 46)?

RESPONSE 3(b): MVP will test water supplies identified within the 500-foot buffer, as requested by landowners, unless both of the following criteria are met: (1) the water supply is not likely to be used as a private water supply (e.g., there is no home on the property) and (2) the location of the water supply is such that it could not potentially be affected by construction (e.g., spring is outside of the construction easement and upslope). In karst areas, subject to the expanded 500-foot buffer, MVP has made every effort to locate springs by civil survey or field observation for evaluation and sampling, although access was at times limited by property owners or physical impediments. However, MVP has given particular attention to wells and springs downslope or downgradient of the construction zones and if warranted, all would be sampled. Not all springs would be in areas that are subject to potential impact by construction, such as those that are upslope from the pipeline and more than 150 feet away.

COMMENT 3(c): Explain the rationale on the large discrepancies between sampling distances for PWSs and residential supplies (3 miles vs 150 - 500 ft).

RESPONSE 3(c): MVP will make all reasonable attempts to identify water supply sources within 150 feet of work areas and 500 feet in karst terrain through civil surveys, GIS mapping, desktop review, and field observation. Additionally, MVP will contact property owners via mail to gather information regarding their water supply. If a private water supply source was identified, MVP requests permission to collect samples for water quality analyses.

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If no response is received after approximately 30 days, a second letter request will be sent by certified mail. If a property owner declines participation in the pre-construction water testing program, this will be documented and MVP will suspend further requests from the property owner.

MVP proposes to conduct two rounds of pre-construction base-line sampling. The first pre-construction sampling event will provide MVP with the opportunity to evaluate and photo document the condition of each well or spring, as well as the overall physical setting and condition of the supply. MVP proposes to collect one sample approximately six (6) months before construction and a second sample within three (3) months prior to construction to account for seasonal quality changes. Well yield tests will be conducted during the second event where approved by the property owner.

MVP established the sampling distances to be consistent with requirements in FERC's regulations for the identification of water resources in the vicinity of the project. Those regulations require MVP to identify all "known public and private groundwater supply wells or springs within 150 feet of proposed construction areas" and "any potable water intake sources within 3 miles downstream" of a waterbody crossing. 18 C.F.R. 380.12(d)(1), (9); see also FERC Guidance Manual for Environmental Report Preparation, August 2002, p. 3-25. The default 150-foot sampling distance for private water supplies was expanded to 500 feet in karst areas to provide an added margin in those geologically sensitive areas. To screen for any potential public water supplies within the study area, the baseline sampling plan includes identification of all public water supplies in any HUC-10 watershed crossed by MVP through the pipeline alignment. This task was followed by contacting each of the public water systems to gather accurate information relative to the public water system, surface intakes, or groundwater wells.

COMMENT 3(d): The testing plan does not discuss how water quality or well efficiency impact from the construction activities will be determined. How large of a difference in pre- and post-construction WQ parameters or pump test data will it have to be and who makes that determination?

RESPONSE 3(d): No post-construction sampling is proposed. MVP's construction practices (including, for example, erosion and sediment controls, materials handling plans, and karst identification and avoidance measures) are designed to avoid potential impacts on water quality or quantity. However, complaints or concerns from water supply owners will be thoroughly investigated by MVP and qualified water supply consultants. The investigation would include comparing the current samples to the baseline testing samples conducted prior to the start of construction. Although every water supply location will have unique hydrogeological features, a typical assessment of water quality or quantity concerns will include collection or review of data concerning:

- Nature of concern (quality, quantity, or both);
- Timeline data (history, when was an issue perceived);
- Baseline conditions (pre-existing observations and conditions from the pre-construction baseline evaluation);
- Weather related data (extremes in dry or wet conditions);
- Location (what activities were ongoing and how close did they occur to the water supply);

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- Hydrogeologic setting (distance from the surface activities, surface and groundwater flows, soil and bedrock types and conditions); and
- Re-sampling for quality concerns and possibly yield tests for quantity concerns.

After data collection and review, a letter summary would be prepared and submitted to the property owner to present the information and provide a determination of the findings and recommendations. As noted in Resource Report #2, MVP is committed to ensuring that construction practices do not negatively impact a private or public water supply.

COMMENT 4: Responses to the following questions regarding the Hydrostatic Testing discussion in Section 4 (page 4-101 unless otherwise specified):

COMMENT 4(a): Provide a latitude/longitude or identify the reach of river in which the withdrawals are expected to occur. The Table identified a mile post (MP) for the proposed water source. Explain if this is the post where the hydrostatic testing will occur on the pipeline or the location of the surface water withdrawal.

RESPONSE 4(a): MVP no longer intends to obtain the hydrostatic test water via surface water withdrawal and will instead utilize municipal water supply sources for hydrostatic testing activities. Should it become necessary to obtain this volume via surface water withdrawal, MVP will work directly with DEQ-OWS regarding permit requirements and conditions.

COMMENT 4(b): Provide an assessment of the river flows where withdrawals for hydrostatic testing are proposed with a discussion of how the withdrawals will affect flows, particularly during low flow or drought conditions.

RESPONSE 4(b): MVP no longer intends to obtain the hydrostatic test water via surface water withdrawal and will instead utilize municipal water supply sources for hydrostatic testing activities. As such, no further assessment has been provided. Should it become necessary to obtain this volume via surface water withdrawal, MVP will work directly with DEQ-OWS regarding permit requirements and conditions as well as completing any additional assessments.

COMMENT 4(c): Explain if any downstream water users may be affected by these water withdrawals, particularly during low flow periods. DEQ OWS can provide information of nearby intakes once the location of the withdrawals is known.

RESPONSE 4(c): MVP no longer intends to obtain the hydrostatic test water via surface water withdrawal and will instead utilize municipal water supply sources for hydrostatic testing activities. As such, no impact to downstream water users is anticipated as result of the project. Should it become necessary to obtain this volume via surface water withdrawal, MVP will work directly with DEQ-OWS regarding permit requirements and conditions. Any information on nearby surface water intakes would be appreciated.

COMMENT 4(d): Table 4.3.2-10 should identify the HUC and river basin of each waterbody to determine if the water is being moved to the different watersheds. Please provide an updated table.

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RESPONSE 4(d): MVP no longer intends to obtain the hydrostatic test water via surface water withdrawal and will instead utilize municipal water supply sources for hydrostatic testing activities. Should it become necessary to obtain this volume via surface water withdrawal, MVP will work directly with DEQ-OWS regarding permit requirements and conditions.

COMMENT 4(e): Attachment RR1-19 Table 1.7-1 should list the DEQ – Office of Water Supply as an agency to consult with regarding the withdrawal of water for hydrostatic testing and also for withdrawals related to dust control.

RESPONSE 4(e): MVP has been in correspondence with Mr. Anthony Cario and Mr. Kip Foster of the Virginia Department of Environmental Quality. This correspondence is provided in Attachment 3. However, MVP no longer intends to obtain the hydrostatic test water via surface water withdrawal and will instead utilize municipal water supply sources for hydrostatic testing activities. Should it become necessary to obtain this volume via surface water withdrawal, MVP will work directly with DEQ-OWS regarding permit requirements and conditions. Please refer to Attachment 4: DEIS Table 1.5-1: Major Environmental Permits, Licenses, Approvals, and Consultations Applicable to the Proposed Projects.

COMMENT 5: Identify the members of the Karst Specialist Team referenced in the Karst Mitigation Plan (pages 266-284) and their qualifications. Will the Karst Specialist be the one onsite during all phases of karst pipeline construction?

RESPONSE 5: Members of the Karst Specialist Team have not yet been identified but will have the following qualifications:

- Must be geologists registered in the state of Virginia and demonstrate sufficient professional knowledge
 of West Virginia (as no state licensure exists);
- Must have field experience in karst mitigation techniques;
- Must be familiar with karst hydrogeology and associated karst features of the project area;
- Must be familiar with state karst protection, and general karst assessment and mitigation guidelines;
- Must be familiar with local and state erosion and sediment control, and stormwater management guidelines, ordinances and regulations; and
- Please Note: Karst Specialist Team members will be in addition to project engineers, managers, inspectors and construction monitors who implement construction activities on a normal basis.

Karst Specialists will be onsite during all phases of pipeline construction in karst areas. Please refer to **Attachment 5: Karst Mitigation Plan** for additional information.

COMMENT 6: Provide a summary map (suitable for GIS software use, if possible) of areas that used existing LIDAR and what resolution to ensure that the highest resolution LIDAR data was used for karst feature identification throughout the entire route referenced in Section 3.3 of the Karst Mitigation Plan (the report states that VGIN LIDAR was used to delineate sinkhole boundaries).

RESPONSE 6: GIS files were provided via email on November 10, 2016 and November 17, 2016 for the areas in the vicinity of the proposed alignment where publicly-available LIDAR data are available for assisting with desktop analysis of potential kart hazards. As noted in the **Attachment 1: Karst Hazards Assessment**, MVP

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implemented field reconnaissance to supplement and verify the desktop analysis for karst features. Please note that no reference was found in Section 3.3 of the Karst Mitigation Plan.

COMMENT 7: Provide additional information regarding the process to deal with any unexpected Karst features found during construction. Please explain what contingencies will be in place for if excavation results in the unroofing of a previously unknown significant cave system and what parameters would be used to determine if the cave is significant enough to be protected by the Virginia Cave Protection Act. How would a late stage discovery of such a feature affect the pipeline progress and alignment if the feature could not be avoided within the current ROW? Does the Karst Specialist have the ability to stop further construction activities until a karst feature is fully characterized (via dye tracing, cave surveying, surface geophysics) and the ability to seek a pipeline realignment that falls outside of the current ROW if a significant karst feature is deemed unable to be properly mitigated?

RESPONSE 7: Mountain Valley has prepared a Karst Mitigation Plan that discusses contingency plans for uncovering karst features, identifies the individuals responsible for notifying the appropriate agency representatives and has stop work authority. Please refer to **Attachment 5 - Karst Mitigation Plan**.

COMMENT 8: As referenced on PDF page 465, page 4-228 of the draft EIS, there are 6 sites of potential contamination concern in Virginia located within 200 feet of pipeline.

COMMENT 8(a): Are any of these six sites listed in Table 4.3.1-3 (PDF page 314, page 4-77)?

RESPONSE 8(a): Of the six sites identified in Table 4.3.1-3, three of the sites have been avoided by reroutes and are no longer located within 200 feet of the pipeline corridor. Please refer to **Attachment 6: MVP – Potential Sites of Contamination – Virginia** for updated information.

COMMENT 8(b): Provide additional information, including the address, of the William D. Smith Trucking contaminated groundwater site that is identified in Table 4.3.1-3.

RESPONSE 8(b): Please refer to **Attachment 6**: **MVP – Potential Sites of Contamination – Virginia** for further information on the William D. Smith Trucking site.

COMMENT8(c): Provide the name, PC# and address of the six sites of potential contamination concern in Virginia within 200 feet of the pipeline that are referenced on page 4-288.

RESPONSE 8(c): Please refer to **Attachment 6: MVP – Potential Sites of Contamination – Virginia** for further information on each of the six sites identified above.

COMMENT 9: Provide files (shapefiles or layers) that are suitable for use in GIS software that have data on the following topics:

COMMENT 9(a): The hydrography/stream layers used to assess crossings.

RESPONSE 9(a): The requested information was provided via email to Julia Wellman on November 11, 2016.

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COMMENT 9(b): Layers used to assess wetland crossings

RESPONSE 9(b): The requested information was provided via email to Julia Wellman on November 11, 2016.

COMMENT 9(c): Any LIDAR data

RESPONSE 9(c): The requested information was provided via email to Julia Wellman on November 16, 2016.

COMMENT 9(d): If you do not have GIS layers for wetlands and stream locations, please provide the information that was used.

RESPONSE 9(d): The requested information was provided via email to Julia Wellman on November 11, 2016.

COMMENT 10: Provide a corrected Table 4.3.2-10 (from October 2016 submission) and/or provide clarification regarding the following areas of inconsistency in the table:

COMMENT 10(a): Segment 10A in the revised Table 4.3.2-10 (October 20 document) has the water intake location for hydrostatic testing on the Blackwater River at MP 262.8, which is from the September MP location. The pipeline now crosses the Blackwater River at MP 269.8

RESPONSE 10(a): MVP no longer intends to utilize surface water withdrawal as a hydrostatic test water source and will utilize municipal water supplies for hydrostatic test activities in Virginia. As such, all water withdrawal information has been removed from Table 4.3.2-10. Please refer to **Attachment 7: Table 4.3.2-10** for updated information.

COMMENT 10(b): Segment 10A in the revised Table 4.3.2-10 (October 20 document) has a required water volume of 4,689,542 gallons. That is then used in section 10B and discharged at MP 249.6 with a volume of 1,181,335 gallons. Then the remnant is used in section 10C and discharged at MP 259.4 with a volume of 1,431,921 which leaves 2,076,286 gallons unaccounted for.

RESPONSE 10(b): Please refer to Attachment 7: Table 4.3.2-10 for updated information.

COMMENT 10(c): Segment 11B in the revised Table 4.3.2-10 (October 20 document) has the water intake location for hydrostatic testing on the Blackwater River at MP 262.1, which is from the September MP location, which has now been replaced around with an alternative route. The pipeline now crosses the Blackwater at MP 269.8; the current location of MP 262.1 is along Teels Creek. If that is the case, then the intake volume of 5,262,310 gallons would represent 71% of the area weighted discharge of Teels Creek at MP 262.1 based on flows at USGS station 02056900. That would be too much of a drawdown of the stream over the course of one day.

RESPONSE 10(c): MVP no longer intends to utilize surface water withdrawal as a hydrostatic test water source and will utilize municipal water supplies for hydrostatic test activities in Virginia. As such, all water withdrawal

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information has been removed from Table 4.3.2-10. Please refer to **Attachment 7: Table 4.3.2-10** for updated information.

COMMENT 10(d): Hydrostatic Testing discharge at MP 267.8 for segment 11B doesn't seem to be located on any waterbody, and in fact is located between small tributaries to the Blackwater River. If it was to discharge on one of those small tributaries, the volume of 715,961 gallons would surely be a large input that could impact aquatic life. This location needs to be clarified, or if in fact it would discharge to a small tributary, the input needs to be less than 10% of the stream flow.

RESPONSE 10(d): The referenced discharge point has been relocated as shown in **Attachment 7**. MVP will discharge all hydrostatic test water in an upland location and will not discharge directly into any waterbodies. Discharge will be conducted through a dewatering structure to prevent accelerated erosion. Dewatering activities will be monitored throughout and will be adjusted accordingly.

COMMENT 11: If already known, provide additional information on the type of fill material proposed to be used in wetlands.

RESPONSE 11: Following installation of the pipeline, MVP will utilize material excavated from the wetland during backfilling and restoration activities. No other material will be utilized for backfilling within wetland areas.

Please feel free to contact me if you have questions regarding the additional information provided or the responses contained.

Sincerely,

Brian M. Clauto

Sr. Environmental Coordinator

B-nCl

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KARST HAZARDS ASSESSMENT (DESKTOP REVIEW AND FIELD RECONNAISSANCE)

Prepared for:



Mountain Valley Pipeline

Suite 1700 625 Liberty Avenue Pittsburgh, PA 15222-3111

October 10, 2016

Prepared by:



DAA Project Number: B14188B-01

Draper Aden Associates (DAA) prepared this document (which may include drawings, specifications, reports, studies and attachments) in accordance with the agreement between DAA and Mountain Valley Pipeline, LLC.

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TABLE

Table 1 – Stratigraphic Nomenclature (table embedded in report text)

Table 2 - Karst Features and Hazards Analysis

APPENDIX A - MAP SET

Map Sheets (1-37) for Karst Hazards Assessment

1.0 INTRODUCTION

Mountain Valley Pipeline, LLC (Mountain Valley), a joint venture between EQT Midstream Partners, LP and affiliates of NextEra Energy, Inc., WGL Holdings, Inc. Vega Energy Partners, Ltd., RGC Midstream, LLC, and Con Edison Gas Midstream, LLC, is seeking a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC) pursuant to Section 7(c) of the Natural Gas Act authorizing it to construct and operate the proposed Mountain Valley Pipeline (MVP) Project located in 17 counties in West Virginia and Virginia. Mountain Valley plans to construct an approximately 301-mile, 42-inch-diameter natural gas pipeline to provide timely, cost-effective access to the growing demand for natural gas for use by local distribution companies, industrial users and power generation facilities in the Mid-Atlantic and southeastern markets, as well as potential markets in the Appalachian region.

The proposed pipeline will extend from the existing Equitrans, L.P. transmission system and other natural gas facilities in Wetzel County, West Virginia to Transcontinental Gas Pipe Line Company, LLC's (Transco) Zone 5 compressor station 165 in Pittsylvania County, Virginia. In addition to the pipeline, MVP project components will include approximately 171,600 horsepower of compression at three compressor stations along the route, as well as measurement, regulation, and other ancillary facilities required for the safe and reliable operation of the pipeline. The pipeline is designed to transport up to 2.0 million dekatherms per day (MMDth/d) of natural gas. Resource Report 1 provides a complete summary of the MVP project and a general location map of the MVP components.

This Karst Hazards Assessment (KHA) presents the results of desk top review and field reconnaissance identifying karst hazards. The KHA is part of the MVP Resource Report 6, which was prepared and organized according to the FERC Guidance Manual for Environmental Report Preparation (August 2002). Resource Report 6 describes existing geologic setting and resources, potential impacts, geologic hazards and mitigation in relation to MVP components.

Mountain Valley previously submitted interim drafts of the KHA to FERC in October 2015 and April 2016 that identified karst features and associated hazards along the initial proposed alignment and various alternatives of the MVP. The current KHA submitted herein presents an

assessment of karst features and associated hazards within 1/4-mile of the currently October 20 proposed route.	016

2.0 KARST FEATURES AND ASSOCIATED HAZARDS

Figure 1 illustrates the proposed MVP alignment and alternatives (including the current October 2016 proposed route) that are underlain by karst terrain. Figure 2 and Figure 3 illustrate more detail in terms of MVP alignment and alternatives underlain by karst terrain in West Virginia and Virginia, respectively.

Karst features within ¼-mile (generally termed the secondary karst buffer) and within 150 feet (corresponding to the construction easement) of the October 2016 proposed route were identified through desktop review of public and proprietary data (discussed below). Field confirmation was completed on properties where landowners allowed access in order to verify the desk top review results and identify previously unmapped karst features.

Karst features identified within the secondary karst buffer (½ mile) and the construction easement (150 feet) are summarized in Table 2, and are illustrated in Map Sheets 1 through 37 in Appendix A. Karst features associated with minor potential for impact are highlighted in yellow, and with moderate potential for impact in orange. Mountain Valley made numerous adjustments to the proposed MVP alignment to avoid significant karst features (note that there are no red highlighted karst features or concerns in Table 2). Karst features that are at negligible risk from pipeline construction, or pose negligible risk to pipeline construction and long-term operation, are not highlighted in color in Table 2.

Mountain Valley prepared a Karst Mitigation Plan (under separate cover) that provides mitigation protocols for karst features that cannot be avoided through minor variations within the construction easement. Mountain Valley will deploy Karst Specialist inspection teams during construction to monitor karst features and provide recommendations for avoidance or mitigation.

2.1 Methods for Desktop Review and Field Reconnaissance

The KHA was completed under the direction of the Project Karst Specialist, who holds qualifications of a professional geologist having direct work experience with karst hydrology and geomorphic processes. The Karst Specialist team has over 70 years of combined direct field experience evaluating karst features in southern West Virginia and Southwest Virginia (the vicinity of the proposed MVP alignment).

Desk top analysis and field reconnaissance was focused on a 1/4-mile buffer from the proposed alignment (termed herein the secondary karst buffer), which incorporated the 150-foot lateral construction easement. The secondary karst buffer was expanded beyond ¼-mile where the likelihood of karst feature occurrence was deemed to be high. Certain carbonate bedrock formations in southern West Virginia and southwest Virginia are more prone to karstification than are others, and the desktop review and field reconnaissance were focused accordingly.

Desk top analysis included review of publicly available data sources, and data provided by the Virginia Speleological Survey (VSS) or West Virginia Speleological Survey (WVASS). Location information for many karst features was taken from information collected by volunteer amateur cavers, continuously compiled since the early 1940s. Many of these historically-documented karst features, originally mapped on 15-minute USGS topographic quadrangle maps, were transcribed onto more modern 7.5-minute topographic maps and location coordinates estimated. It is noted that information included in the desk top review that was provided by the VSS or WVASS are not associated with guarantees by these sources for accuracy or correctness of any information. Field verification was conducted (where property owner permission was granted) to verify a mapped karst feature and to identify previously undocumented karst features.

The KHA greatly expanded the knowledge base regarding local karst features. More than 12 new cave features were identified. Numerous previously undocumented springs and insurgences were identified and mapped. As well, locations of previously identified features were confirmed and updated. Equally important to identifying karst features, is documenting a lack of karst features in areas that previously had little to no historic karst review. Direct interaction with property owners, commenters, and state agencies during the KHA process facilitated karst feature identification and this additional knowledge will serve as an asset to future karst research efforts. Mountain Valley adjusted the proposed alignment in numerous locations to avoid karst features and mitigate associated hazards using the information gathered through the current and previous KHA efforts.

2.2 Coordination on Geologic Formation Names

The discussion of karst-related hazards presented below includes references to specific geologic formations, and to support that discussion the generalized stratigraphic column from McDowell and Schultz (1990) is presented below, to identify the major rock types in the karst area.

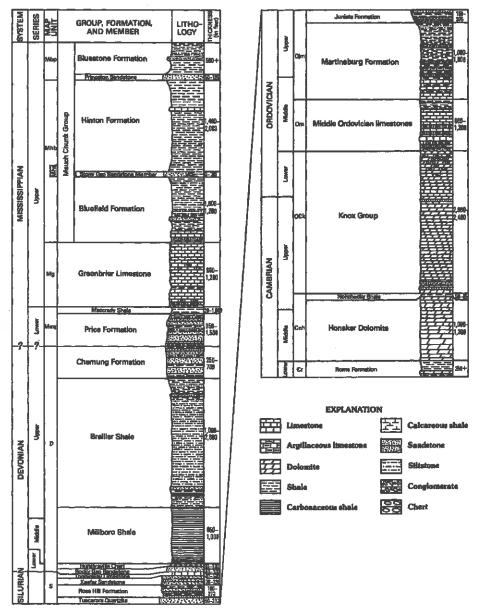


Figure 5. Generalized columnar section for rocks in the Giles County area of Virginia and West Virginia.

Structural and Stratigraphic Framework, Giles County, Vinginia and West Vinginia - ES

From McDowell and Schultz, 1990

For added clarity, we note that geologic formations comprising the local karst terrain are referred to by different names, particularly between practitioners in West Virginia versus Virginia. The geologic mapping work of McDowell and Schultz (1990) presented a useful correlation for formation names, as reproduced below (Table 1).

Table 1. Stratigraphic nomenclature used in this study and other studies in the Giles County area of Virginia and West Virginia

	Mercer, Monroe, and	Giles County, Va., and				
System	Summers Counties, W. Va. (Reger, 1926, fig. 6)	Mercer County, W.Va. (Cooper, 1961, pl. 1)	Botetourt County, Va. (McGuire, 1970)	Southwes (Miller and	Southwestern Virginia (Miller and Meisner, 1977)	This report
	Plusters Grain	Discretion Demonstrat		Bluestone	Upper red member	Dhoetone Demetion
		Directore Formation		_	Formation Lower member	Discount rollismoli.
•	Princeton Conglomerate	Princeton Formation		Princeton S	Sandstone	Princeton Formation
	JK Set				Little Stone Gap Member	Hinton Formation
MISSISSIPMAN	Hinton Group	Hinton Formation	(not exposed)	Penningt Hinton Formation	araber	Stony Gap
	Eluefield Group	Bluefield Formation	1	Bluefield Formation	ion	層
_		"Casper" Limestone				
_		"Ste. Genevieve" Limestone		Consultains I impartion		Consultator Limentons
	Greenoner series	Hillsdale Limestone				
		Little Valley Limestone				
	Maccrady Series	Maccrady Formation		Maccrady Shale		Maccrady Shale
	Pocono Series	Price Formation	Price Formation	Price Siltstone		Price Formation
		Parrot Formation				
	Cheming Series	"Chemung" Formation	Cheming Formation			Circulating Politicaline
•	Portage	Brallier Formation	Brallier Formation	Charamoga Shale	u u	Brallier Shale
		Millboro Formation	Millboro Formation			Millboro Shale
DEVONTAN	Genessee-Hamilton-		Needmore Formation			
	Marcellus Series	Huntersville Formation	Ridgely Sandstone			Huntersville Chert
			Licking Creek Formation	Wildres Velley Sandstone	undetone	
			Healing Springs Sandstone	The second secon	ATMENTS	
	Charlette Series	Rocky Gap Sandstone	New Creek Limestone			Rocky Gap Sandstone
			Keyser Formation			
		Tonoloway Limestone	Tonoloway Formation	Tonoloway Limestone	stone	Tonoloway Limestone
	Clinton Series	"Keefer" Formation	Keefer Sandstone	Rose Hill Formation	ion	Keefer Sandstone
SILURIAN		Rose Hill Formation	Cacapon Formation		Upper red sandstone member	Rose Hill Formation
	White Medina Series	Tuscarora Sandstone	Tuscarora Formation	Sandstone	Lower white sandstone member	Tuscarora Quartzite

From McDowell and Schultz, 1990

Table 1. Stratigraphic nomenclature used in this study and other studies in the Giles County area of Virginia and West Virginia—Continued

System	Mercer, Monroe, and Summers Counties, W. Va. (Reger, 1926, fig. 6)	Giles County, Va., and Mercer County, W.Va. (Cooper, 1961, pl. 1)	Botetourt County, Va. (McGuire, 1970)	Southwestern Virginia (Miller and Meisner, 1977)	This report
	Red Medina Scries	Juniata Sandstone	Juniata Formation	Juniata Formation	Junista Formation
	Martins- Group Burg Eden Group	Martinsburg Formation	Martinsburg Formation	Reedsville Shale	Martinsburg Formation
	Trenton Group			Trenton Limestone	
	Mocrasin Series	Eggleston Formation	Eggleston Formation	Eggleston Formation	
		Moccasin Formation		Moccasin Formation	
		Witten Limestone			
		Gratton Limestone Renholt Limestone	Edinburg Formation		
ORDOVICIAN	Stones River	Pearisburg Limestone		Lower Middle Ordonicism	Important Important
	(Chickamauga) Series	Lincolnshire Limestone	Lincolnshire Formation	limestone formations	
		Five Oaks Limestone			
		Elway Limestone	New Market Limestone		
		Blackford Formation			
			Beekmantowa Formation	-	
	Real-montrum Caries		Chepultepec Formation	Tours Described Poisoning	-,
		Клох Стоир	Cottococheaque Formation	Copper Ridge Dolomite	Клох Стопр
			Copper Ridge Formation	Maynardsville Limestone	
CAMBRIAN	Elbrook? Series	Nolichucky Shale	Elbrook Formation	Nolichucky Shale	Nolichucky Shale
		Honaker Doformite		Honaker Limestone	Honaker Dolomine
		Kome Shale	Rome Formation	Rome Formation	Rome Shale

From McDowell and Schultz, 1990

2.3 Karst Features Identified

Karst features located within the secondary karst buffer (minimum ¼-mile) and construction easement (minimum 150-feet) of the proposed MVP alignment are summarized in Table 2. The karst features presented in the summary table were mapped or otherwise recorded through desktop review. Features that were further characterized through field observation are specifically noted in Table 2. A description of the feature, potential impact to avoid or mitigate, and recommendations are included in Table 2. Note the color-code system for karst features (e.g., white is negligible risk; red is notable risk, etc.). The karst features identified in Table 2 are also shown in the corresponding Map Set provided in Appendix A. Note that the karst features listed in the specific route table includes a cross-reference to the map sheet. Each karst feature listed on Table 2 is associated with a unique identifier number for cross reference to route maps (see Map Sheets in Appendix A).

2.4 Karst Feature Mitigation

Refer to the MVP Karst Mitigation Plan for a detailed discussion on karst hazard mitigation where an identified feature cannot be reasonably avoided within a proposed construction easement, or where an unidentified feature is encountered during construction.

2.5 Bibliography

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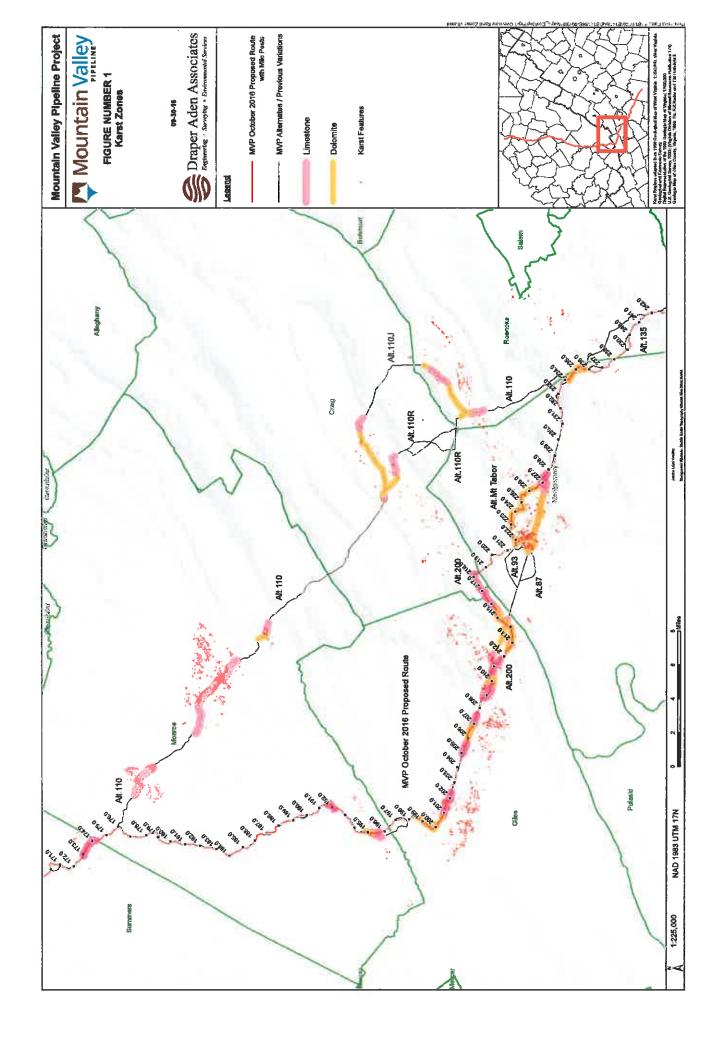
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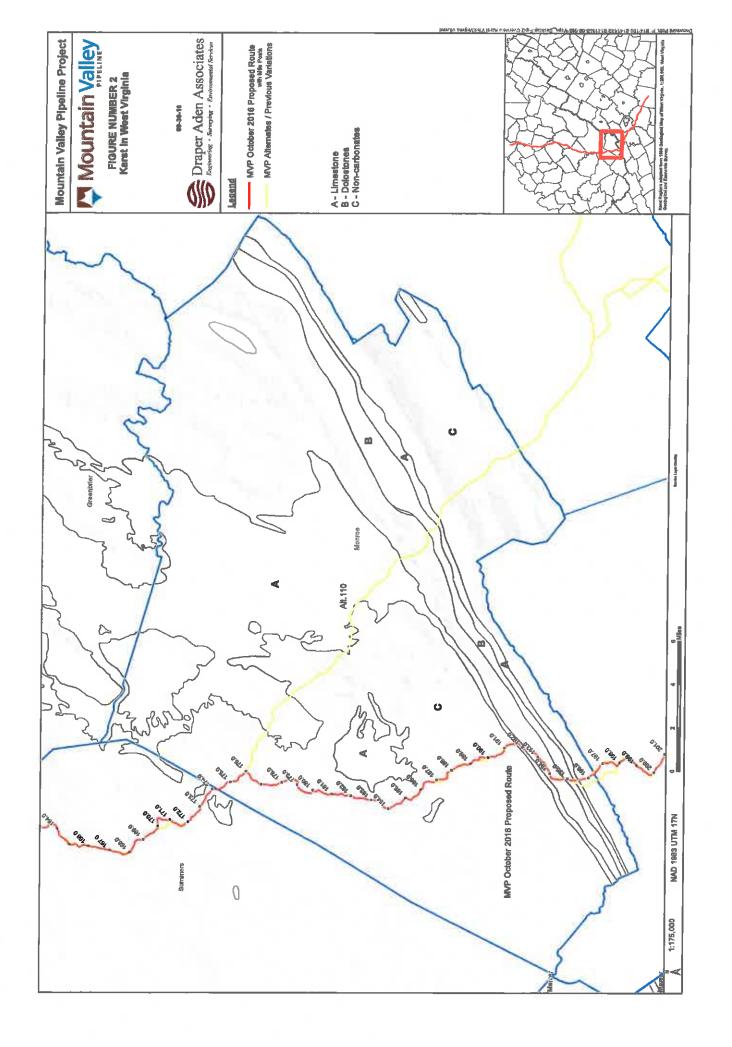
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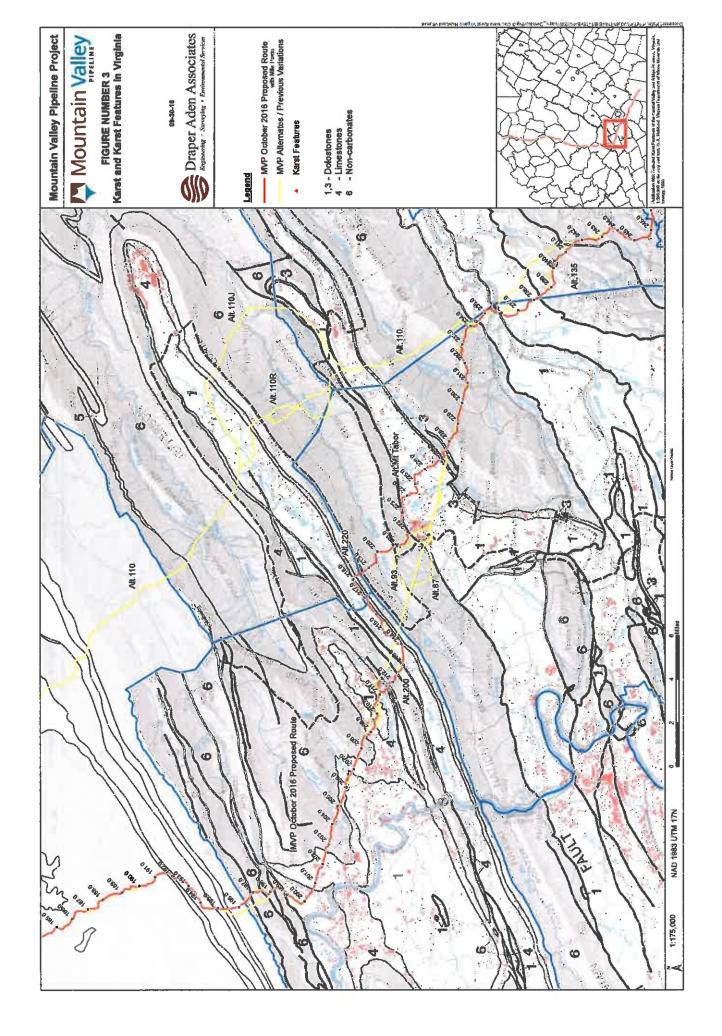
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2.6 Figures 1 Through 3







T	able	2 –	Kar	st Fe	atur	es a	nd Ha	zard	s Ana	lysis				

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209.00	17 0027	Specified comments			Bon Nede (1) at bottom of table	200
206.10	17.623	Control Lord Margaret	G C	1. towards a letter stroom. Multiple Atoms mapped by deskipp server approximately 700 fort [60] confirmed) at proposed alignment	See Nation I at hothern of table	2000
200 and	10301	MINITIONE	Yes	Proposed MVP digment is on edge of ankhole, to left (neathered).	See Make 23 or hotels	1380
209.30	17 0£37	Cave	Yes	Pictobs citte graften besteht neuen than 1 Martin left (neutheaut) of terminal a Reservant	SOUND THE CALL BOWNER OF BURNE	Gibes
209.33	17 of 37	CAN	Yes	Polytile Chair menoments of the state of the	W.B.	Gibe
209 62	18 of 37	Contact - mid Importance	Ves			250
209.75	IR of 37	Sintheda	77	Construction of the state of th	m/a	200
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211.66	20 of 37	Care	Yes	(Hos Hole No. 2. A comulatore assertationally) (40 feet to delite females	E c	Gips
211.67	20 of 37	Contact	You		Nece Note (2) at bottom of table	Glies
212.40	20 of 37	Contact - begin dobratile	Yes	furlt) disnosformite	6.0	G-les
212,89	21 of 37	Contact	Yes	Married of published and published the published to the p	44	- E
213.08	21 of 37	Sintholo	Ves	Control of the Contro		1
214.03	23 of 37	Gimbledan.		Control of the control of the first for metally of all in the control of the cont	See Note (1) at bottom of table	500
-	1	Sanorane Sanorane	Tes	Servers and harmone harmones 30 and 150 feet left (meetineen) of the proposed alignment	See Note (2) at bottom of table	5
21426	72 nc 17	Monneye	Yes	Proposed dispersal one trenschitch, shore and assessments liter for left of a losse serves of the companion of the serves of the companion of	Pleases sensors if the undertool to desired the senior in Araban and consequences that make any	255
214 39	22 of 33	Sintehodos	N.	STREET STREET, THE STREET STREET, STRE	Days. See Note (2) at bottom on that take	(Blc)
214.67	73 of 37	Ginthodes	-		100	199
		- Kovins	100		Dia.	Sec.
214.86	13 of 37	Spring	Yes	Large spring for the design of the control and speciment of the proposed alignment. Abstracts covered the spring's stream. The source is near block.	for Make 2) at Leasure of safety	(4)01
214.90	23 of 37	Cave	Ven	Carried Carried to the Construction of the Carried Car	Shell to the house here	- 68
215.01	23 0(37	Slakbolo	Yes	whole 940 feet canbe /	Been Norte (1) at bestreen of table	Office
215.24	23 of 37	Sinithele	Yes	ı,	North North (1) 4th bottom of fable	200
215.35	23 of 37	Ministerie	Vac	3	Mee Note (2) at bottom of table	1
215 50	24.06.97	Contact havin benefitted		wi :	See Note (1) at bottom of table	200
275.60	240627	O'Libeles	O X		S	
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	2000	Omn Deale	168	Statistics approximately ABU forth west) of proposed alignment.	See Mote (1) at heritage of table	CHIES
216 22	24 of 37	Cave, Stream insurpose	Yes	A posteble antweated at the instruction approximately. Me for night mentioned of the proposed alignment. The alignment is in the clearly of the manganee driving may be relatively now the secretaries and large intended features may be relatively now the secretaries.	See Note 121 of bottom of table	Gles
216 52	25 of 37	Cave, spring, oncom	Yes	Jones Care, a large mains, and misholes, rear with a stream teamingment are 400 to 600 fact left (southwest) of the payoned alignment. The proposed alignment of the payoned alignment of the proposed alignment.		Samo
				digment. A proposed access road along cristing private and form mosts is located not the features and longs Car.	See Note (2) at Bodies of those	Giles/ Cnuig
210.05	25 0737	Strings	Yes	A styring that serves filme (3) houses, hecated approximation 900 fact highs; (southeast) of proposed eliterament	San Maja (1) of hother - Poulls	
216.99	25 of 37	Sinkholes	Yes	pos (stans	Office of Polymon or Salah	# (B)
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417.12	AE 093	Total Control	T.		Star Notes (2) of hothern of tables	
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210.00	43 OF 34	Section 2		ı	San Note (1) at bottom of rabba	Clic
418.19	20 00 37	Sections	Yes	A naidate is bearing accordance y 210 fact left (sorts) of the present all account.	100 March 100 Ma	Crede

1,40. D	St. or at	Darken, Libertification	State Confirmation	The state of the last state of the state of	Britain St. I Tomas Annual Brown and St.	1
	(5) CA II	Name of the Part o	Chest Continues of the	The control of the second of t		
21815	26 of 37	Cave and stream matergoness emichole	Yes	Prospho one atomics and stream picongenes withou as upon Minord michado separatumidas. (40 Doed half doordwant) and absount to Doed Upon a revision half boom the proposed alignment. The alignment is that processed and no second processed alignment is that processed and no second processed alignment of the passegment	See Note (2) at bottom of table	Craig
218.27	26 0[37	Contact	Yes	End of limestone area (approximate).	n/a	Cruix
221.70	27 of 37	Contact - Pulsaki Fault, begin dolomite. Begin Morari Tabor simblede plain	No	Approximent beginging of M. Ever Andrewskie and C. Approximen begins of Physics of Physi	Sen Wote (2) and Wote (3) at bottom of table, MVP is realanting an ademate nigament to seekd too sinkhole point to the autoni practical. The deak top proview of the allemate node suggests less benefits after a color with a subsection of table for certain properties.	Montgomery
23]86	27 0537	Note	S.	Alienment attent crossing as wicinity of Pulsaki Pault, edge of lawst area.	d/a	Montgomeny
221.93	27 0537	Cove. Stream insurance	No	Shacer Charl Care and stream is sursance are approximately 3.000 feet downstream of the proposed alleament.	ωk	Montgomeny
222.26	27 0637	Sinkhole	No		See Note (1) and Note (3) at bottom of table	Monteomery
222 84	28 of 37	Note	Yes		See Note (2) at bottom of table	Montgomery
273.75	78 M 37	Sinthole	Vess		See Note (2) at bottom of table	Montecessory
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223.34	28 of 37	Sinidole	Yes	Owen throat stakes arrangement of feet left mouth.	See Note (2) at bottom of table	Montgomen
223.47	28.62.52	- Andrews	100	١.	New Nation Of a Comment of States	Montpotects
223.30	20 0027	Sinthele	Vers	Sim Petrola terreceisman ships 2 (1) (and related (countries))	See Note (1) at hottom of table	Monteconery
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224.06	29 of 27	Shirbale	Vei	Sinkling immersion and the forest	See Note (2) at bottom of tedta	Menteomery
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270.69	32 00 37	Smichole	Yes		Non to married at promote of mark	MONTENANTA
220.63	32 of 37	Confact - Imentions	You	Approximate section of Lincolnistics New Market, and Filiations; Landschools, High potential for Eding development.		Monthpomery
226.89	32 of 37	Sakhole linesment	You	Served inhibates are imaged by dedup within which the contribute of the proposed MVP pipelies, imaging from approximately 10 to 2,000 feet to the reduced and southwest. This insument may request a furniture or some of the contribute of the contri	See Note (2) at bestean of table	Montecomery
27.23	32 of 37	Spring, Cave	Yes	Johnsons spring, water probably from the helbow to (northward), Johnsons Carb carries a small advent and is approximately 430 feet right (southwast) of proposed MVP alternated. Several sinkholes housted pear Johnsons Care and spring.	See Nove (1) at bottom of table	Montgomery
227.53	32 of 37	Sinkhole Incoment	Yes	Statistics observed sight (west). This linearment may represent a fracture or zone of weakness in the bostroat. There is a possibility of uncentrolidated betweek above the finement extracted.	See Note (1) at bottom of table	Montgomery
227.57	32 oE37	Losing Stream Insurgence	Yes	Louing strong and we weather immysses was observed approximately 100 test right of proposed MVP alignment. May be unsectated with minimals innorment above the water flowers flowers Cave and serves.	See Note (3) at bottons of table	Montgomery
227.70	32 nf 37	Stream instructure	Yes	Streem insurance was observed a symmetric 600 fort left the emission diseases.	See Note (1) at bottom of table	Montepanery
227.70	32 of 37	Contact - end imentone	Year		D/D	Montecesery
16 756	34 of 47	Contract - brain delomite	Nin	The state of the s		Montepenery
234.43	34 of 37	Street in Street,	Yes	A misco stream in its announced (44) foot right (annihmed).	Bee Note (2) at bottom of table	Montgomery
234.53	34 of 37	Sinithols	Yes		See Note (3) at bottom of table	Mentgomery
274.73	26 0623	Shekhale	Ver	The control of the Co	Son Note (2) at bothom of table	Monthentiery
214 (16	24 -527	Sintholn	Ver		Sea Neta (1) at hother of tailo	Montpomery
744 14	14 of 17	Sintholog	Yes		San Nichn (2) at bedform of tubin	Montanenv
215.79	35 of 37	Control	Yes		10/4	Montgomeny
235.79	36 of 37	Note	Yes	No bent features identified in this proposes differents.		Montgomery
238.67	37 of 37	Control	Yes	Find Rotes Formston, Karri satestment ends.	πή	Mostgemery

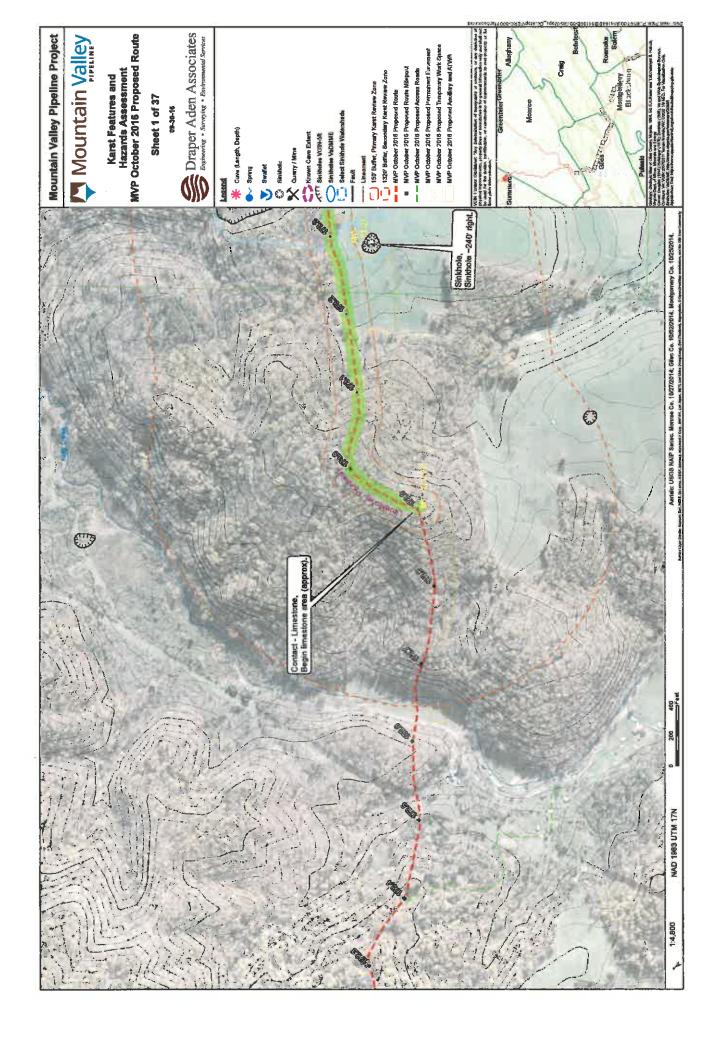
⁽¹⁾⁻ In general, unswinded storm water or constitution telease from the Limit of Disturbance could potentially impact groundwater or surface water via the heart feature(s) or spring, and de socretaints stoll are statistical impacts. Contraction may carceatize principles of the statistic or unsable to distribution to the heart feature or disclaims or feature or disclaims control and Contr

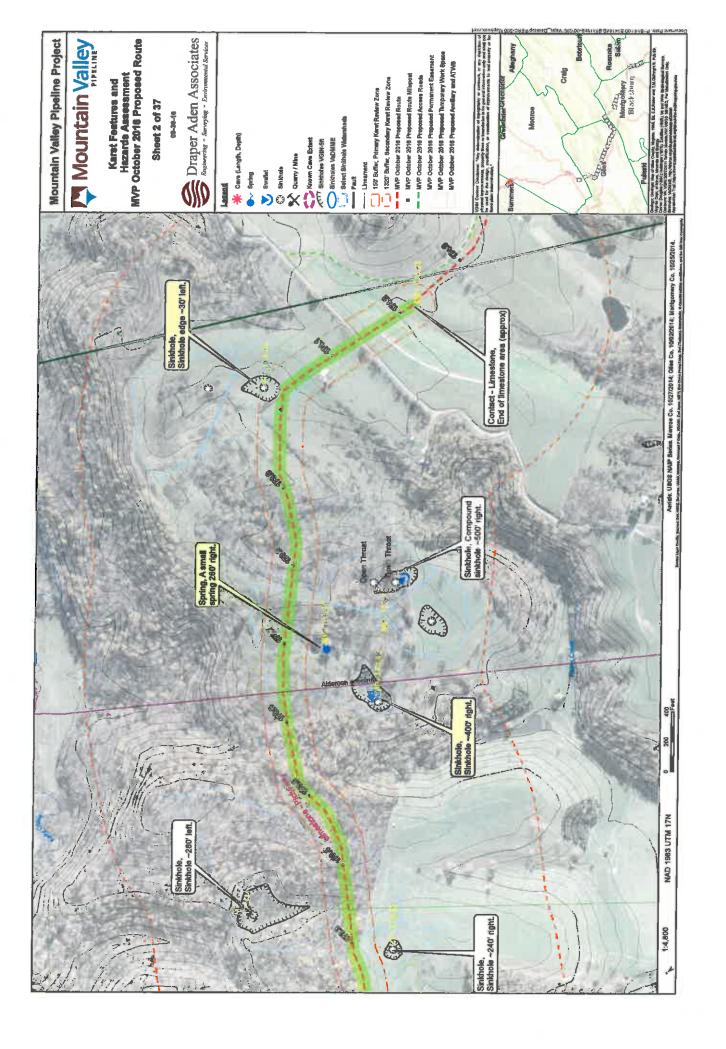
⁽³⁾ The bast fairings is position to the Limit of Therman, to general unconsciouled stem when or contentration-related found relates from the Construction was the Construction was secured to relate the Construction was secured to relate the Construction was presented related by the contentration of the Related to the Less of the Part of the contentration of the Construction was presented principal behavior and the relation of the Relation of the Construction of

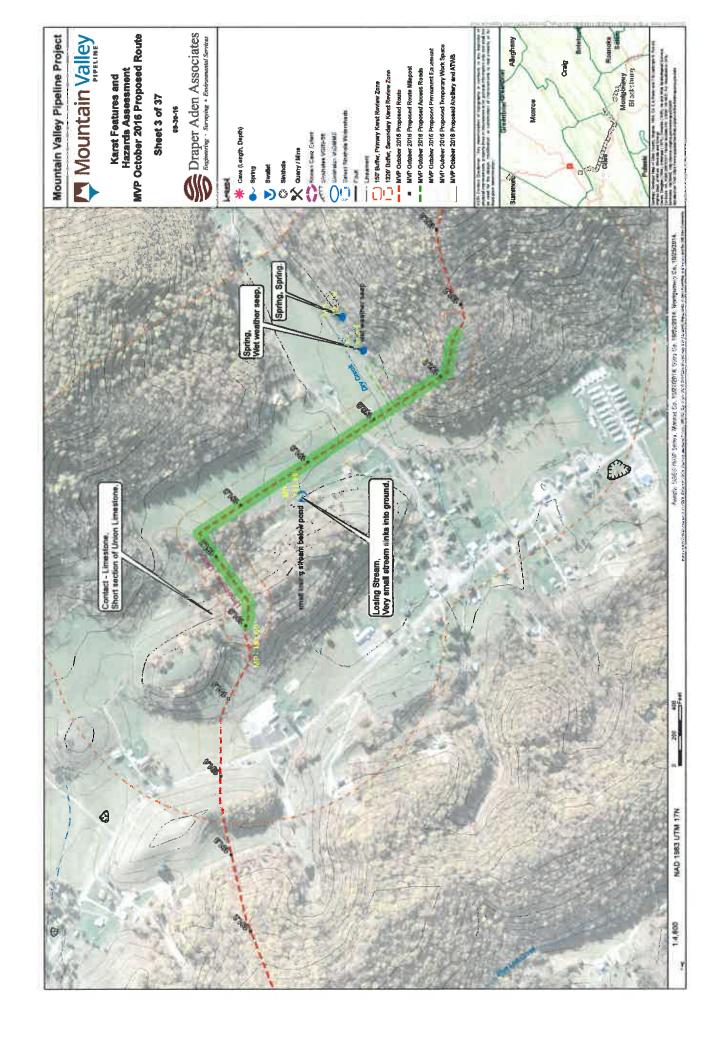
^{(3) -} The primary concern is that MVP wen not permitted access to the property to field weal's knowl feature(s). See News (1) or Nete, (2) showe for recommendations. Further recommendations, Browish MVP permission to constant tield wealther included of the property to field wealth for the property to go presented in the property of the property to go presented in the property of the property to go presented in the property of the property to go propert

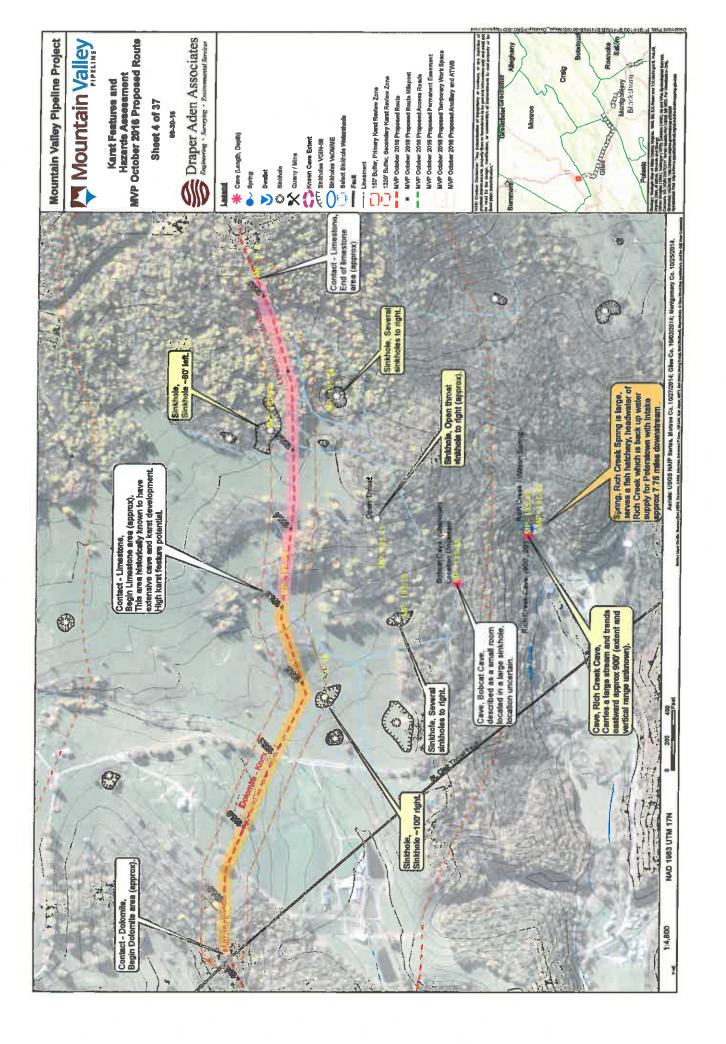


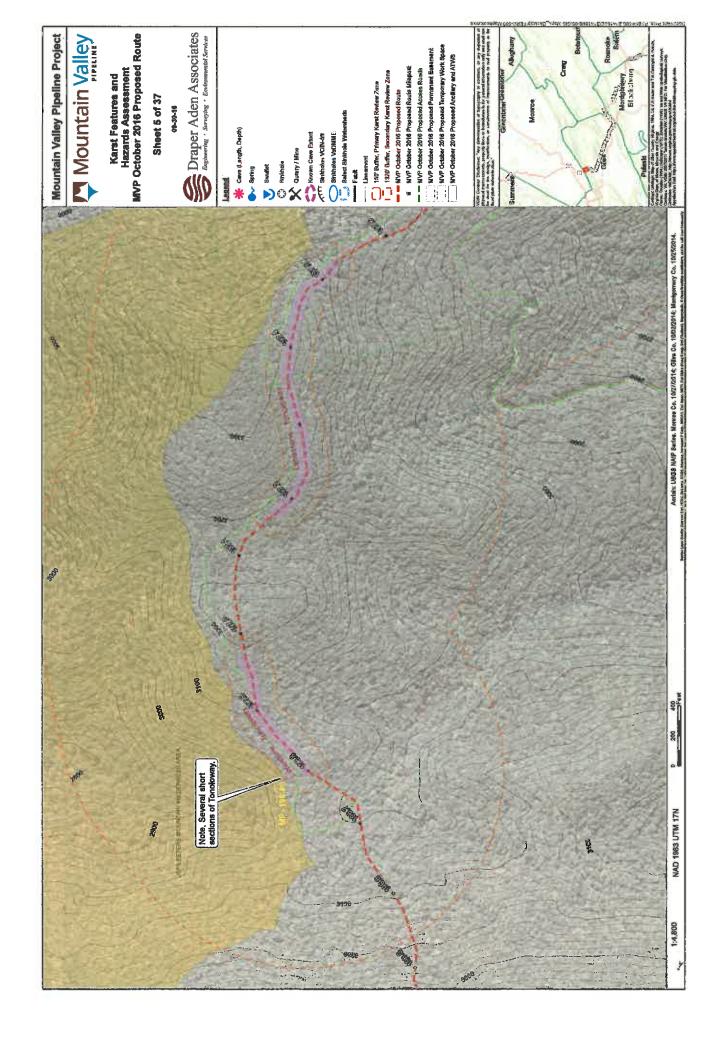
Map Sheets (1-37) for Karst Hazards Assessment

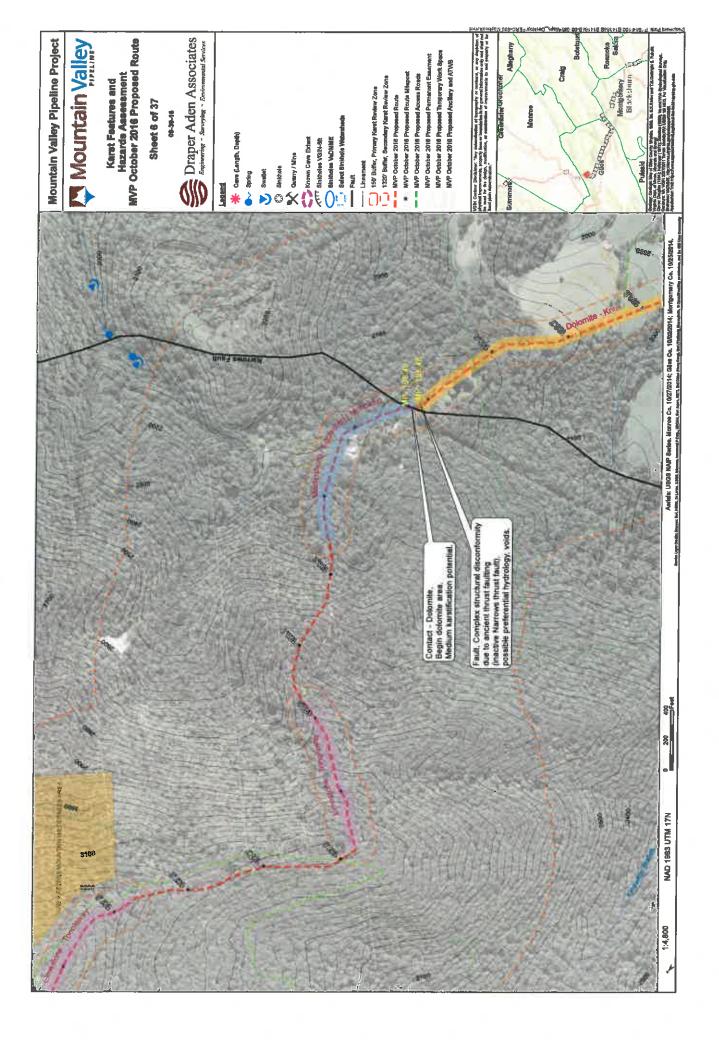


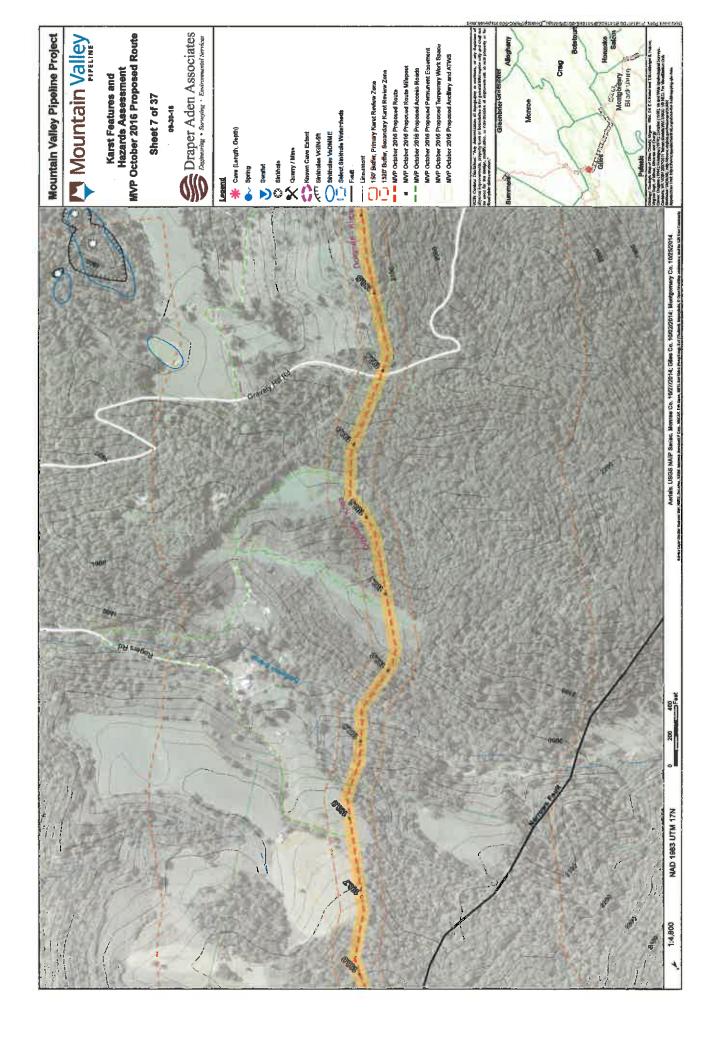


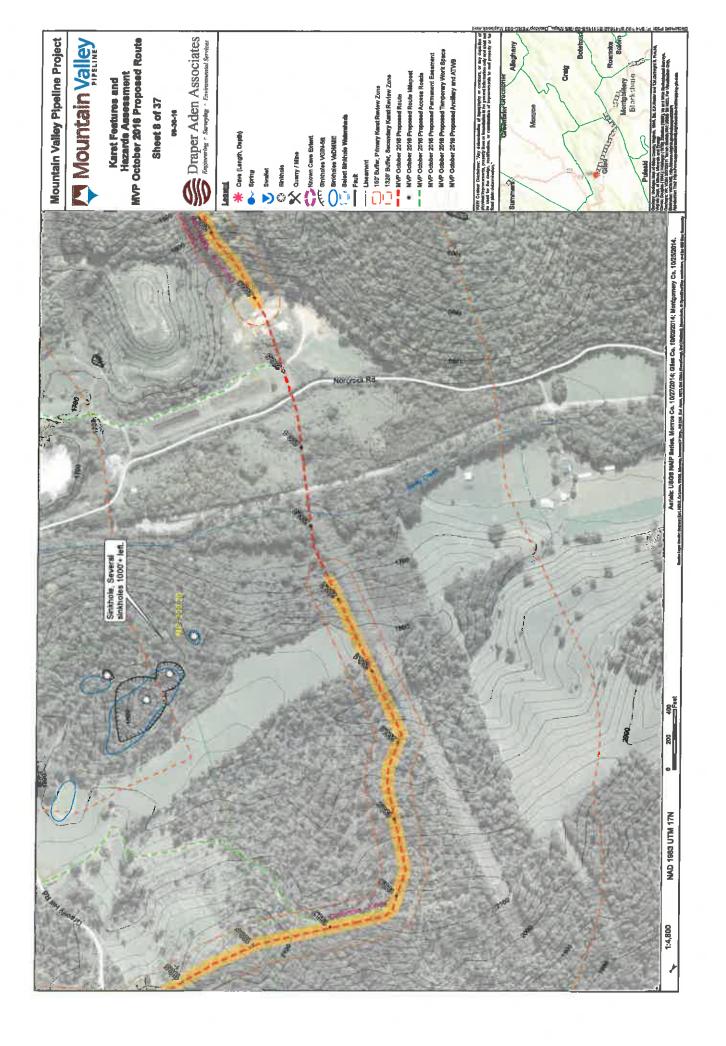


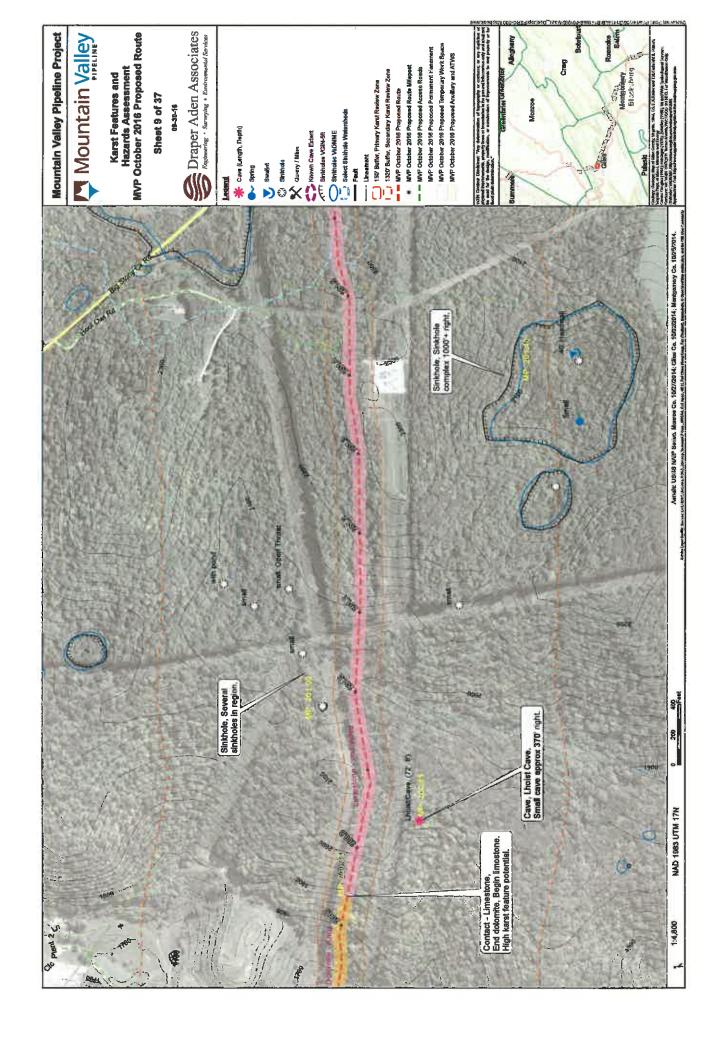


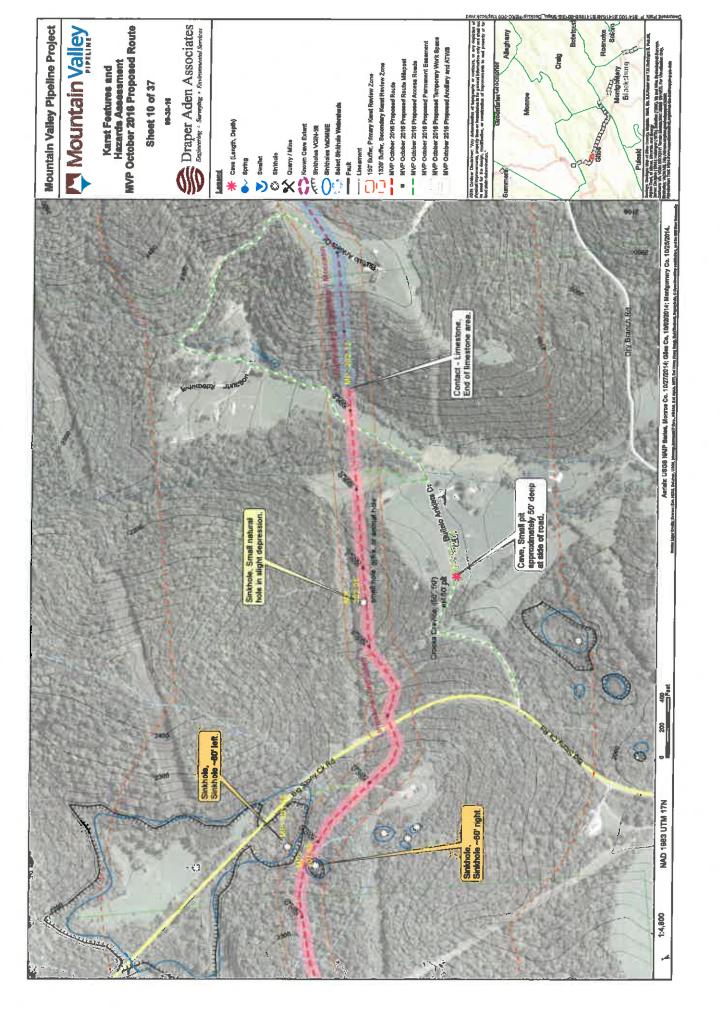


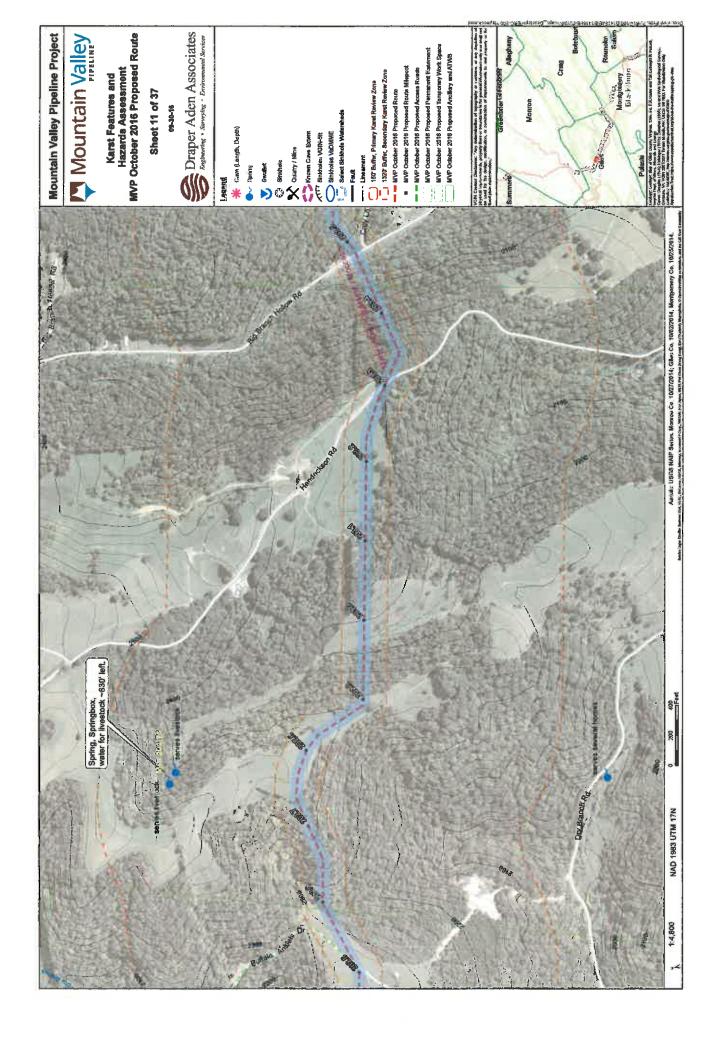


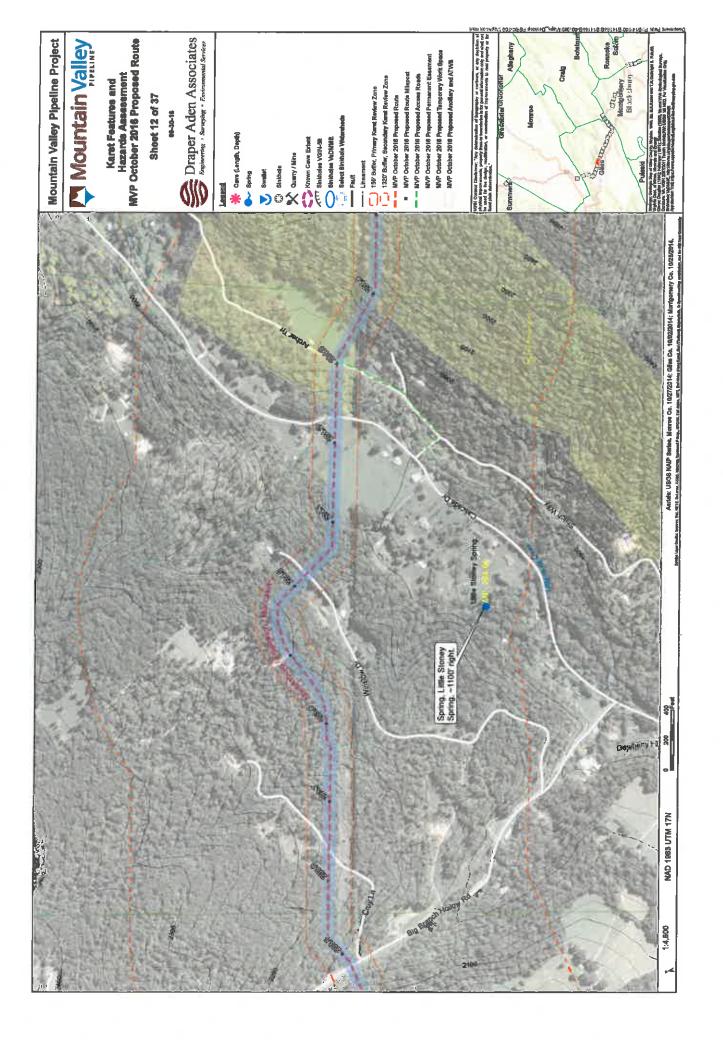


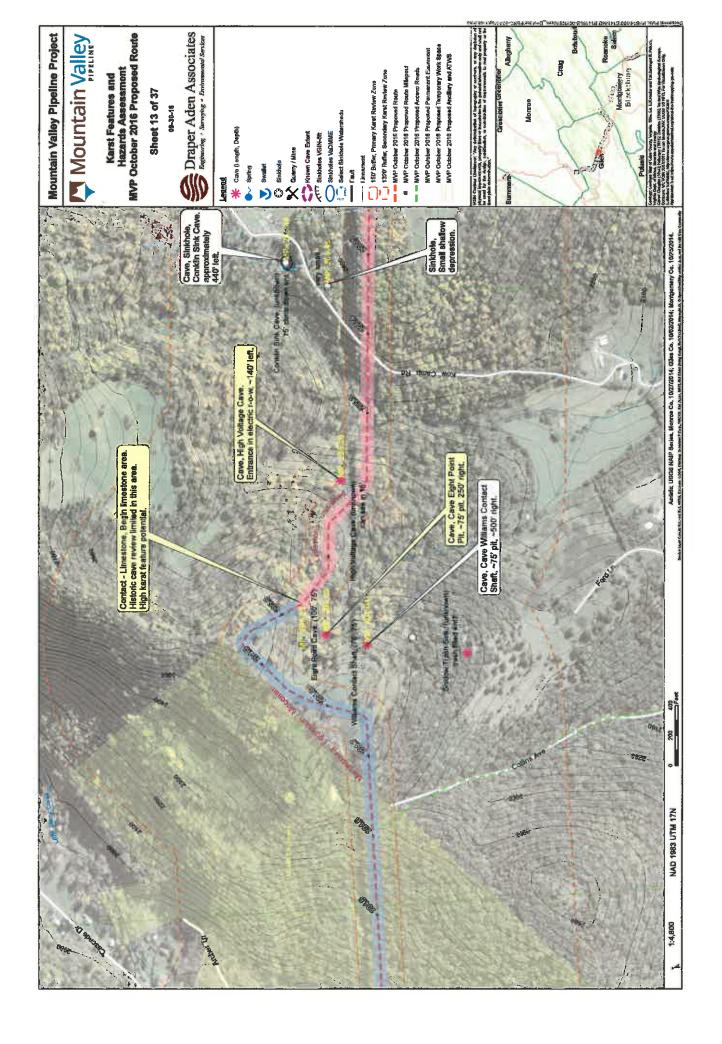


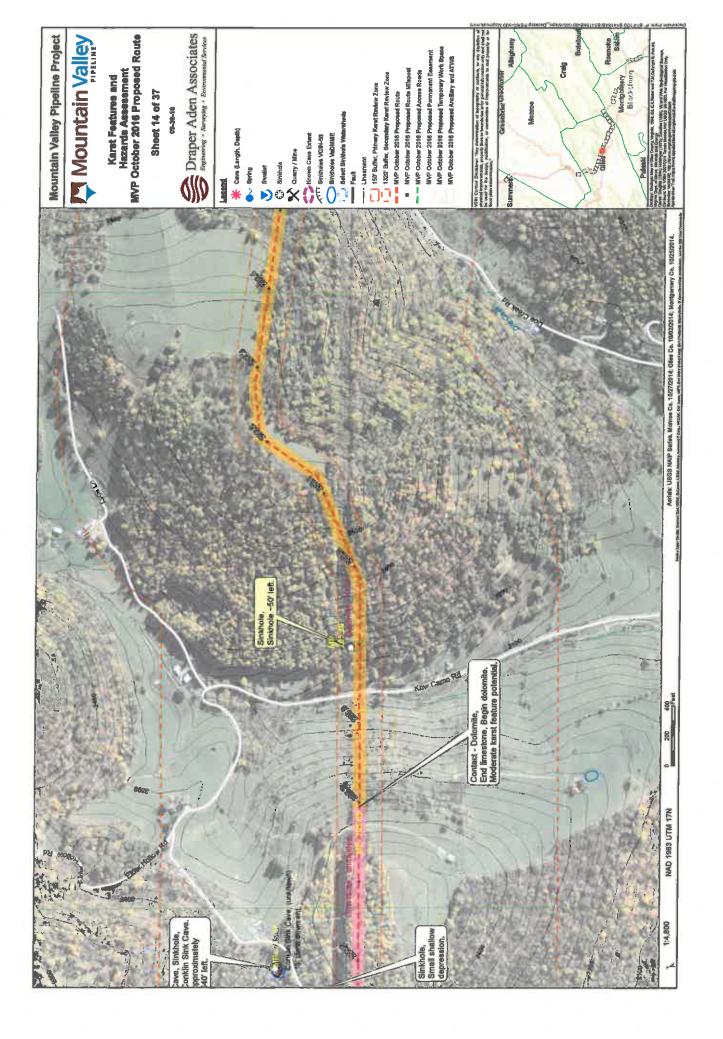


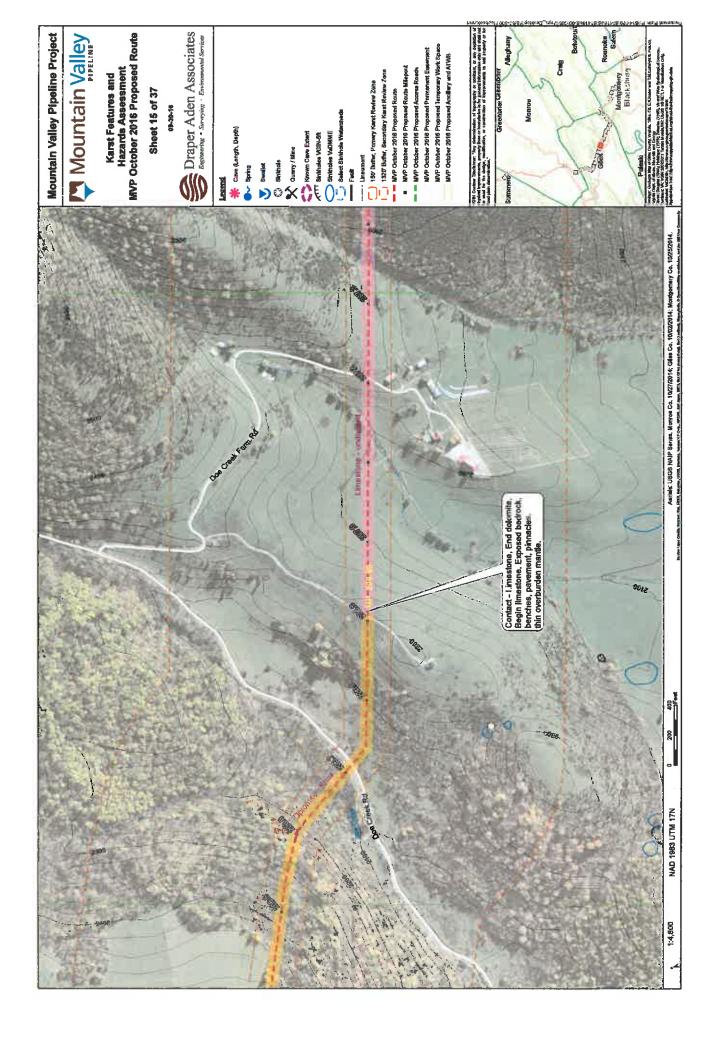


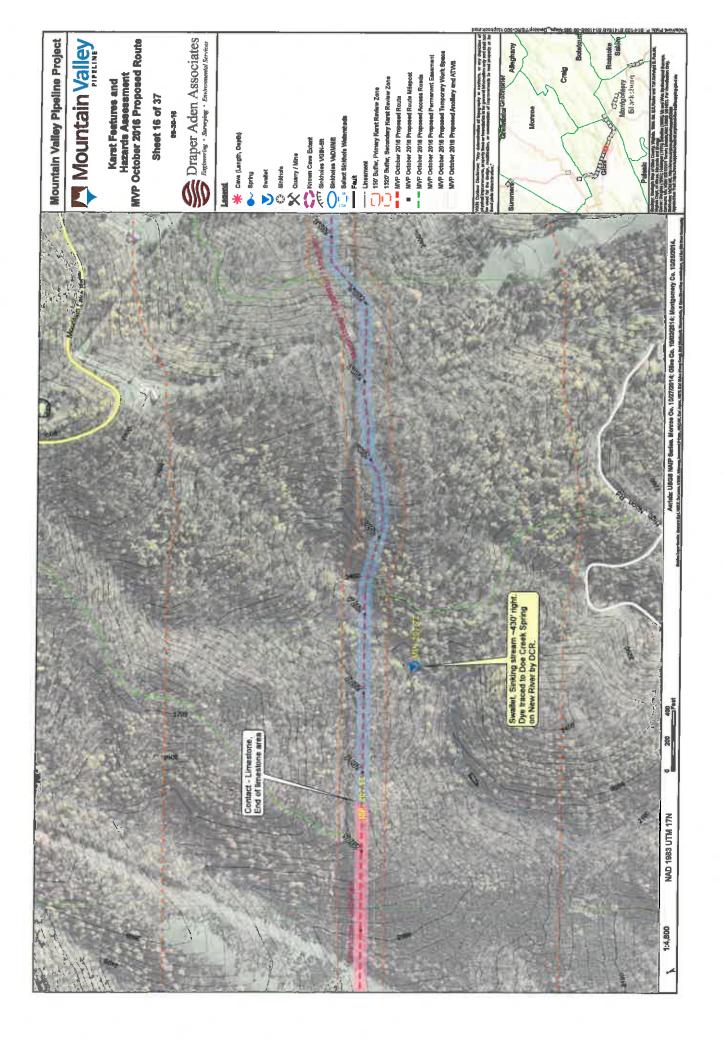


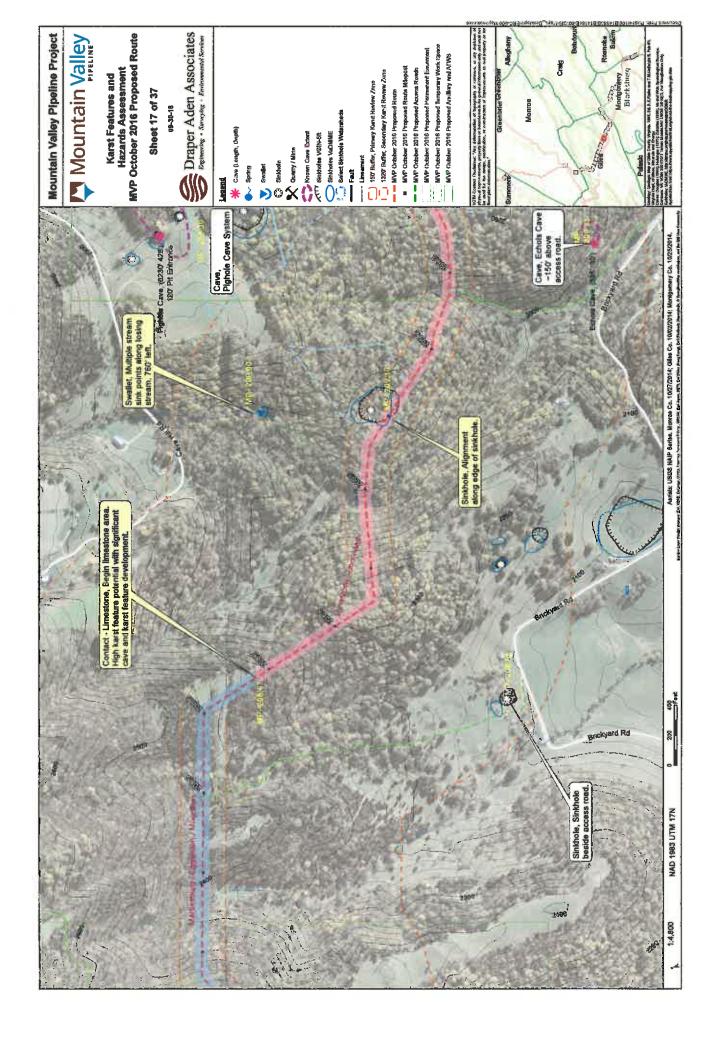


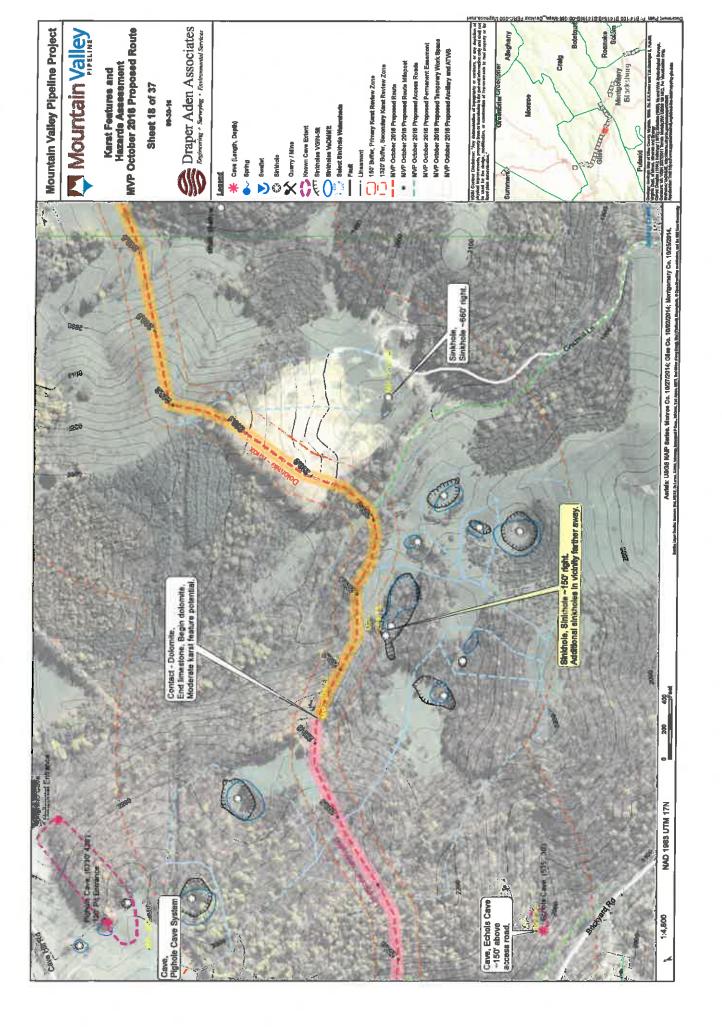


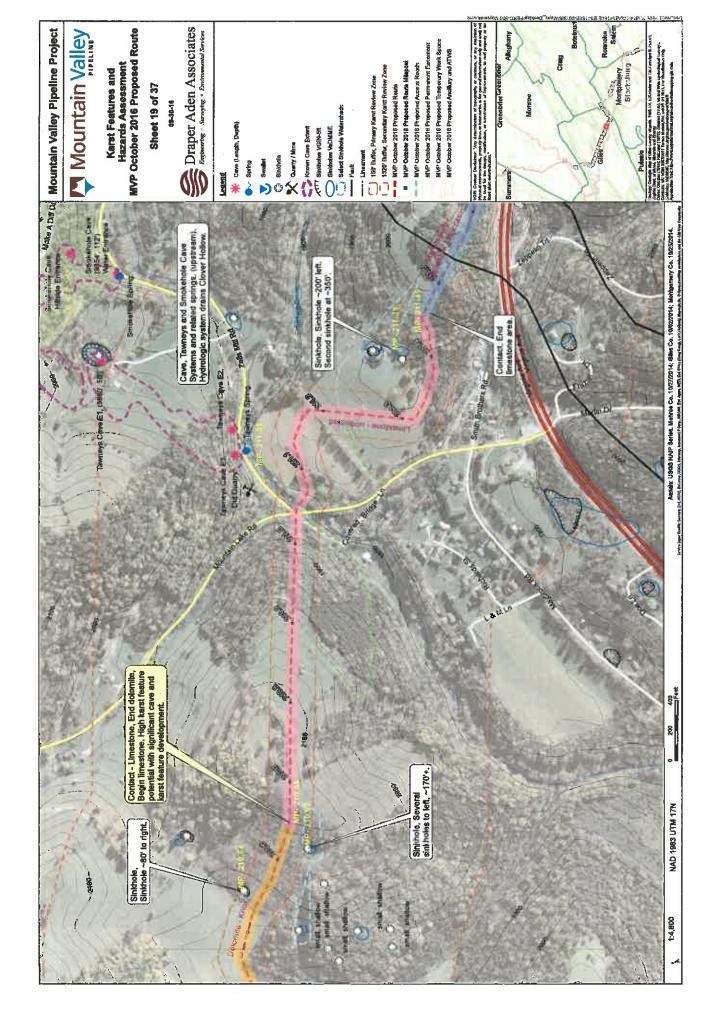


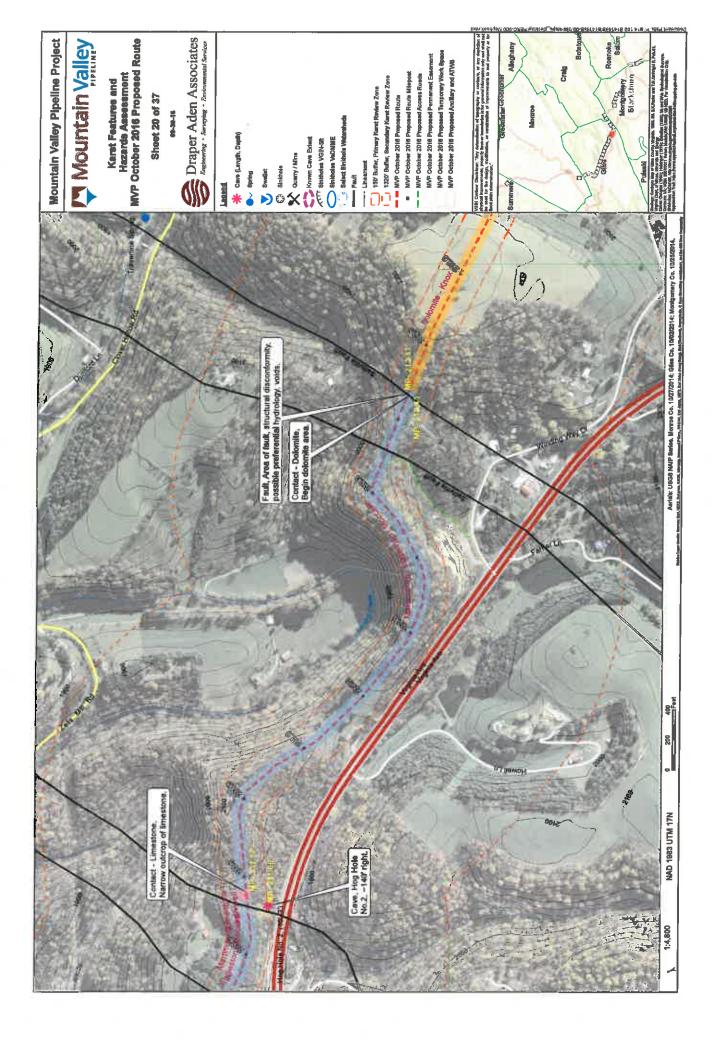


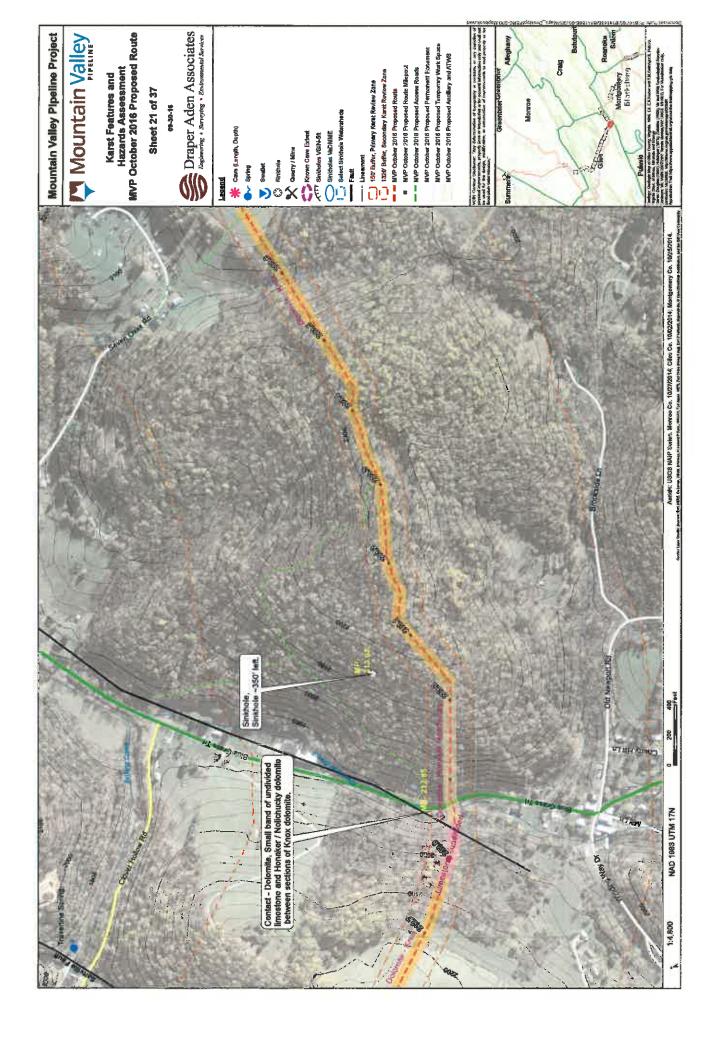


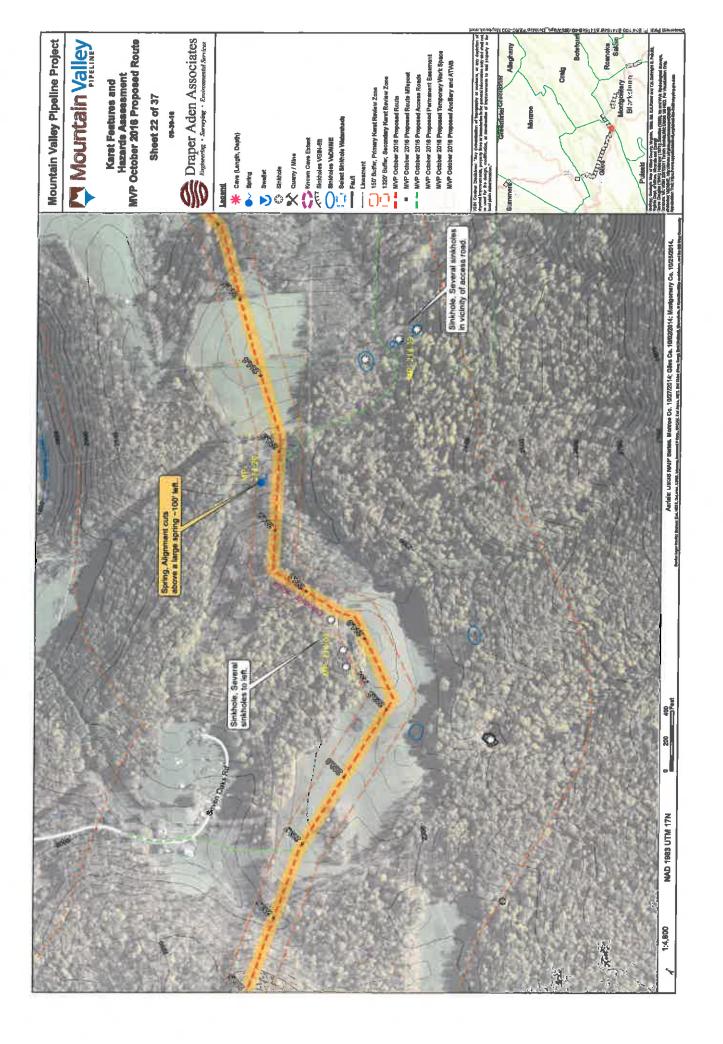


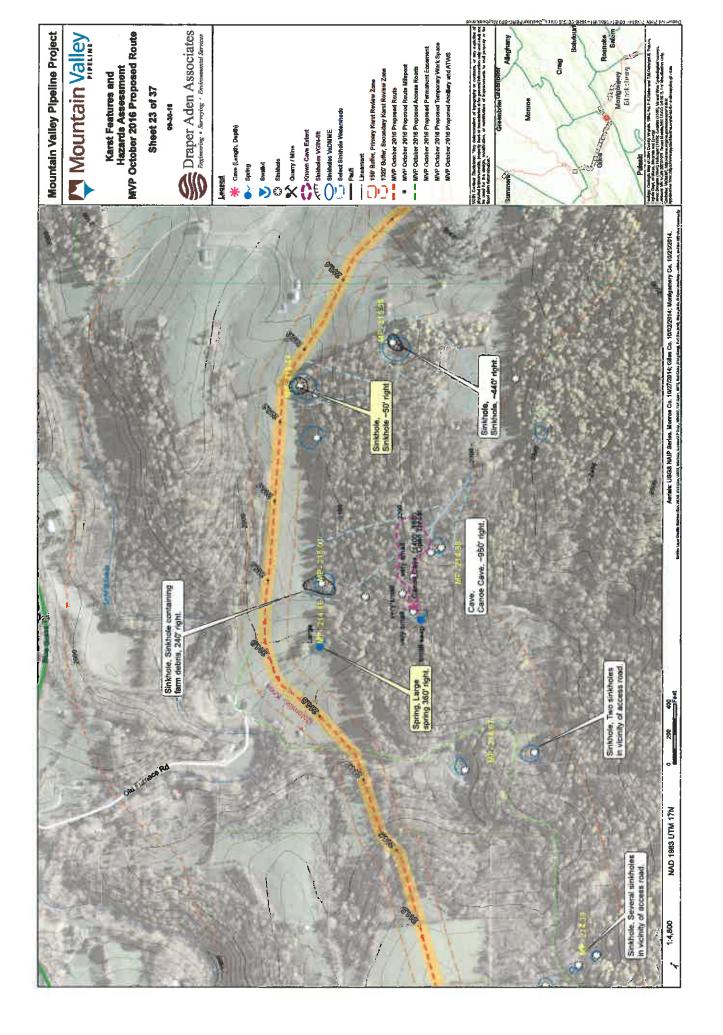


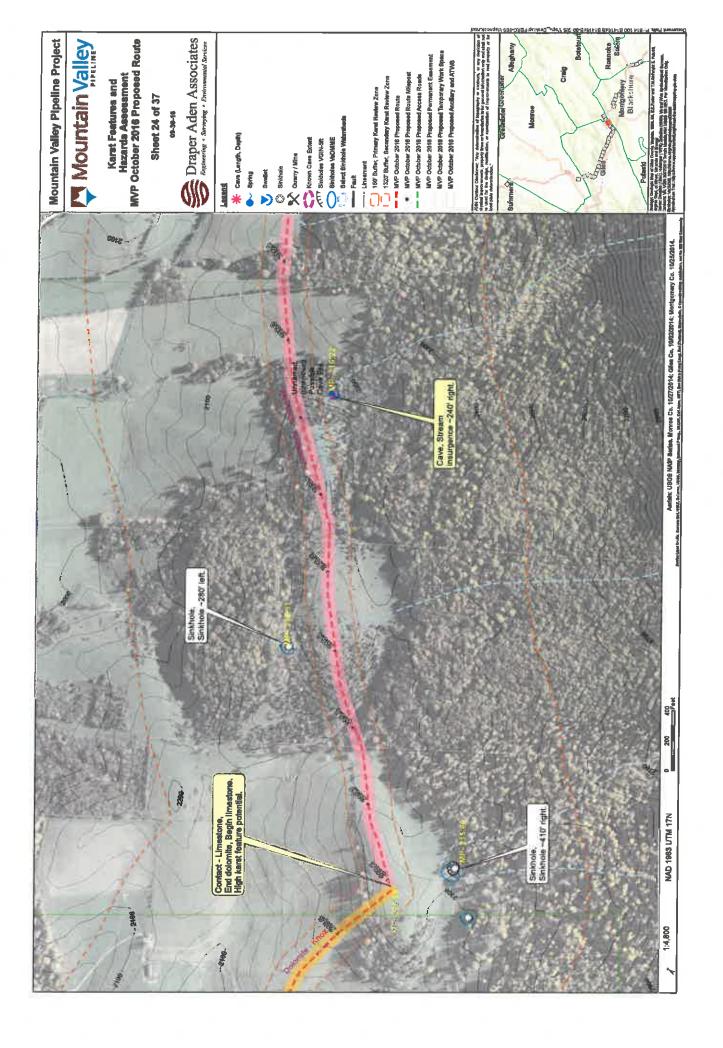


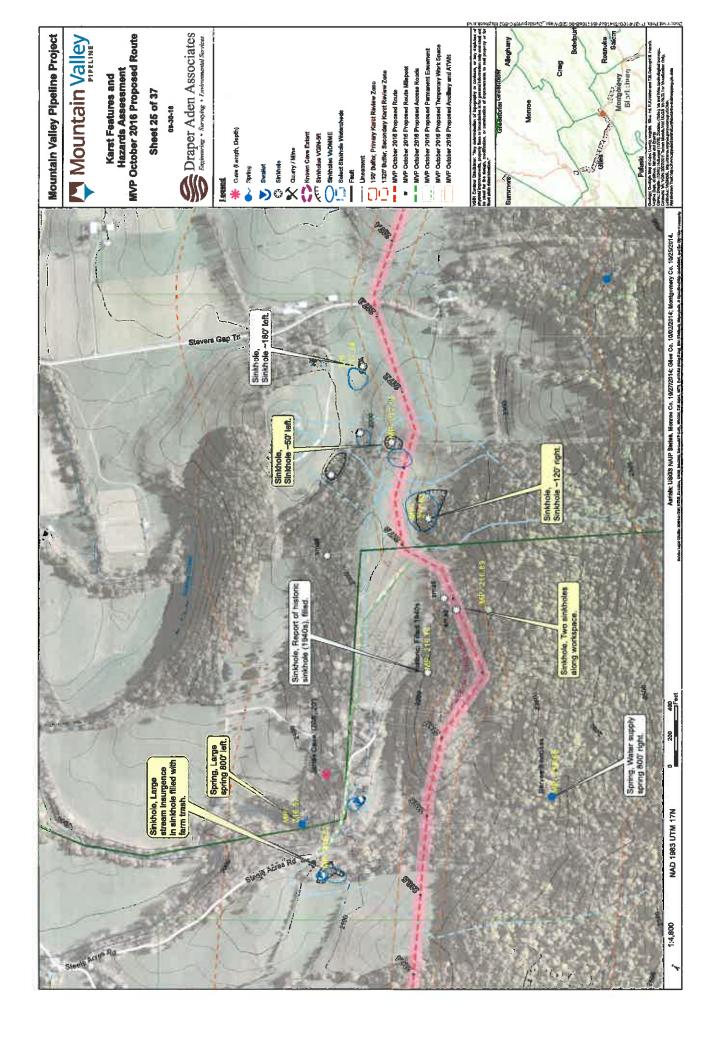


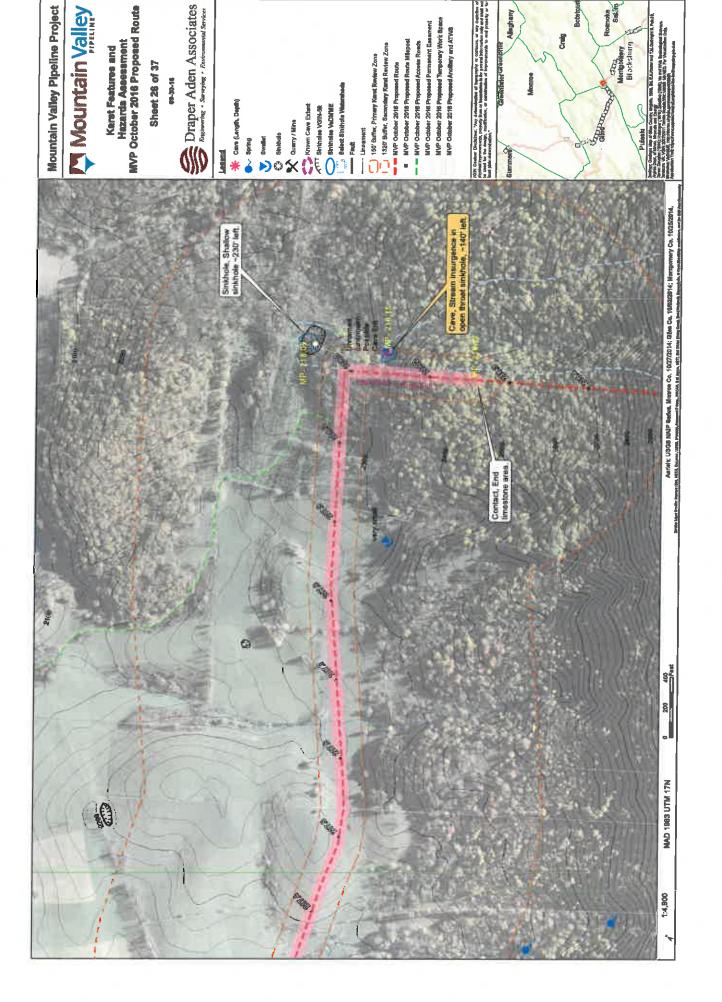


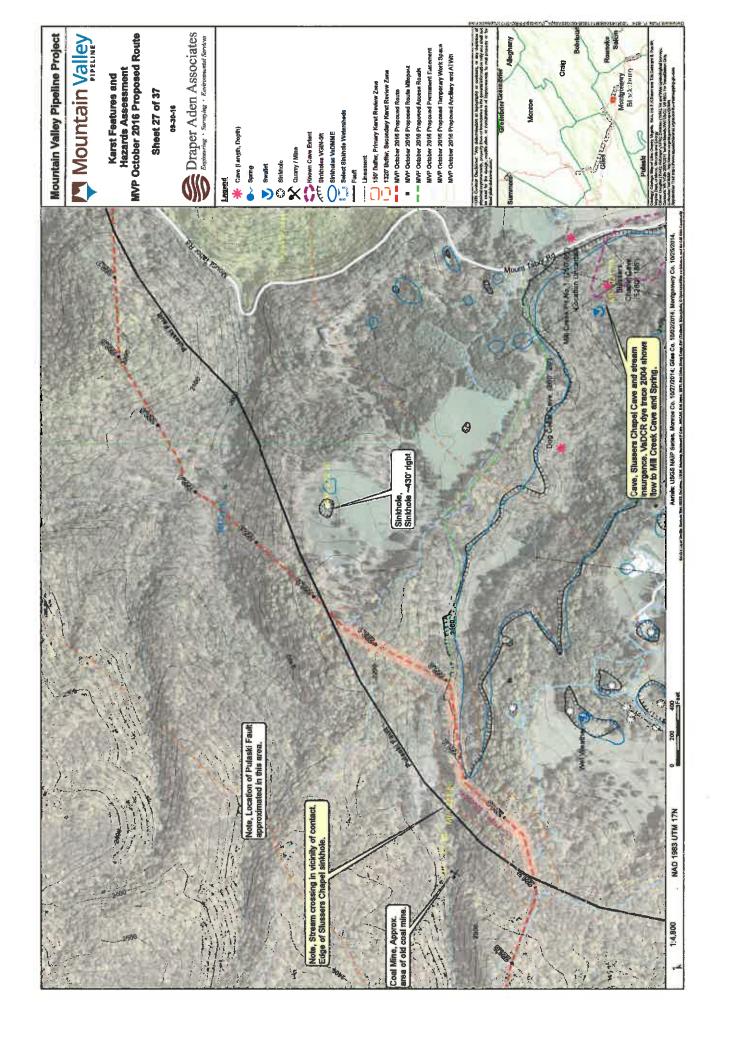


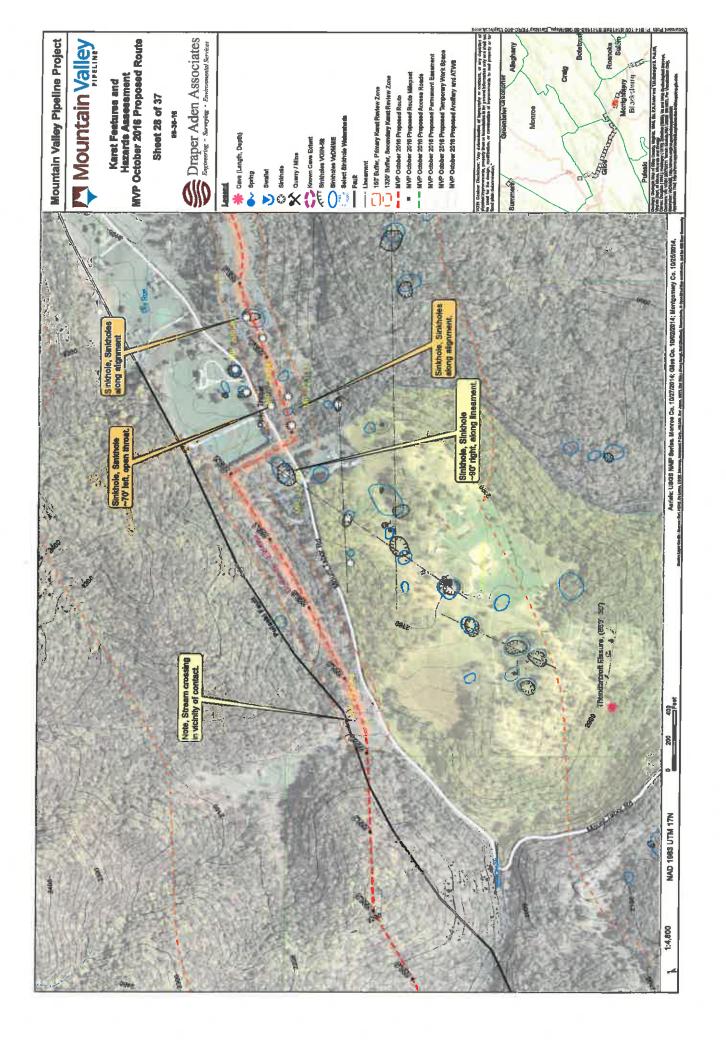


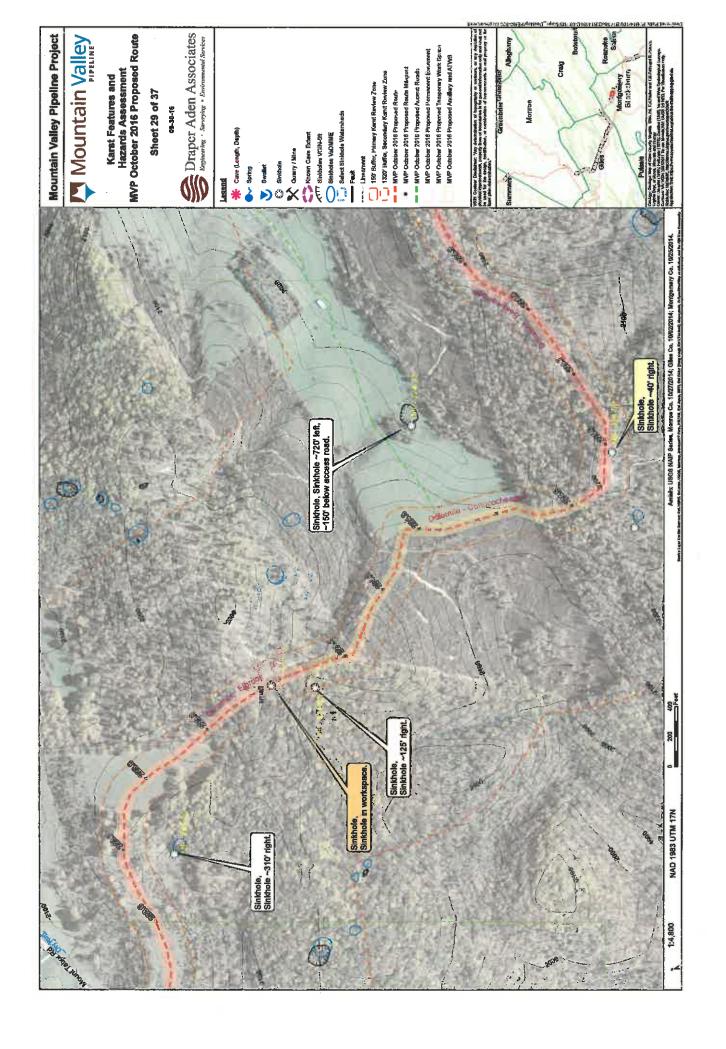


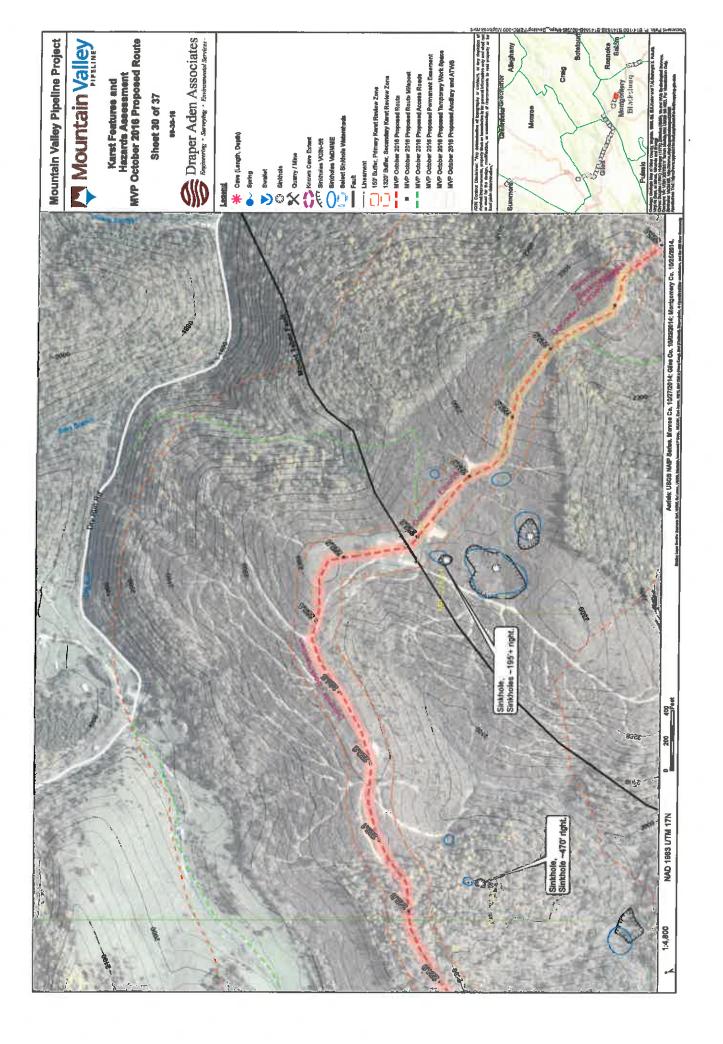


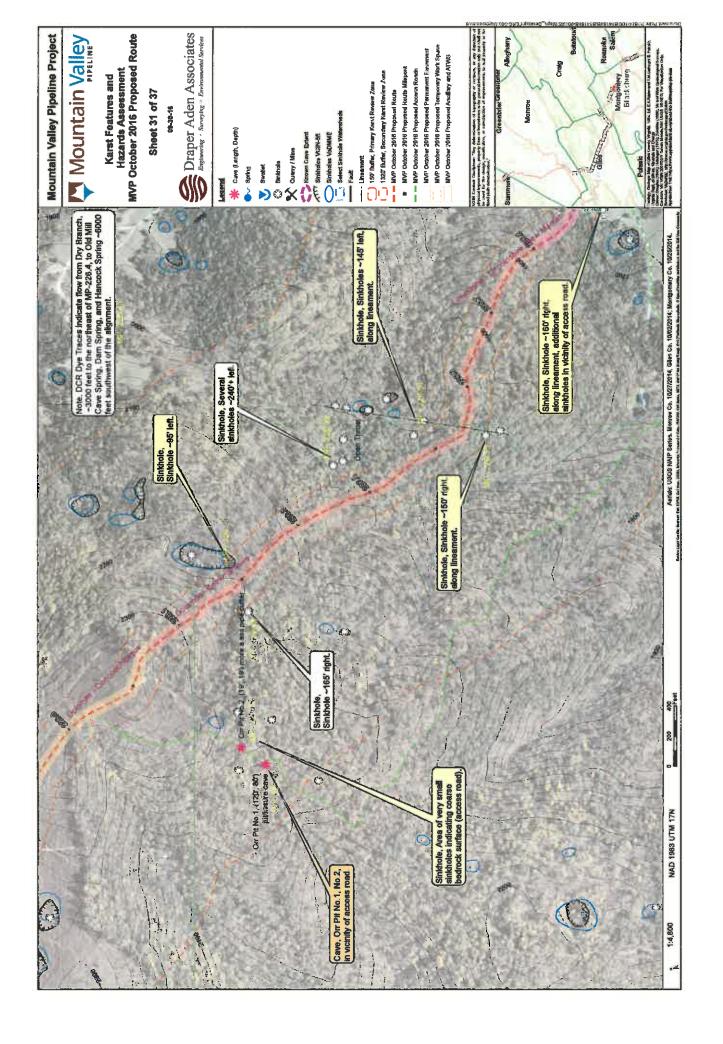


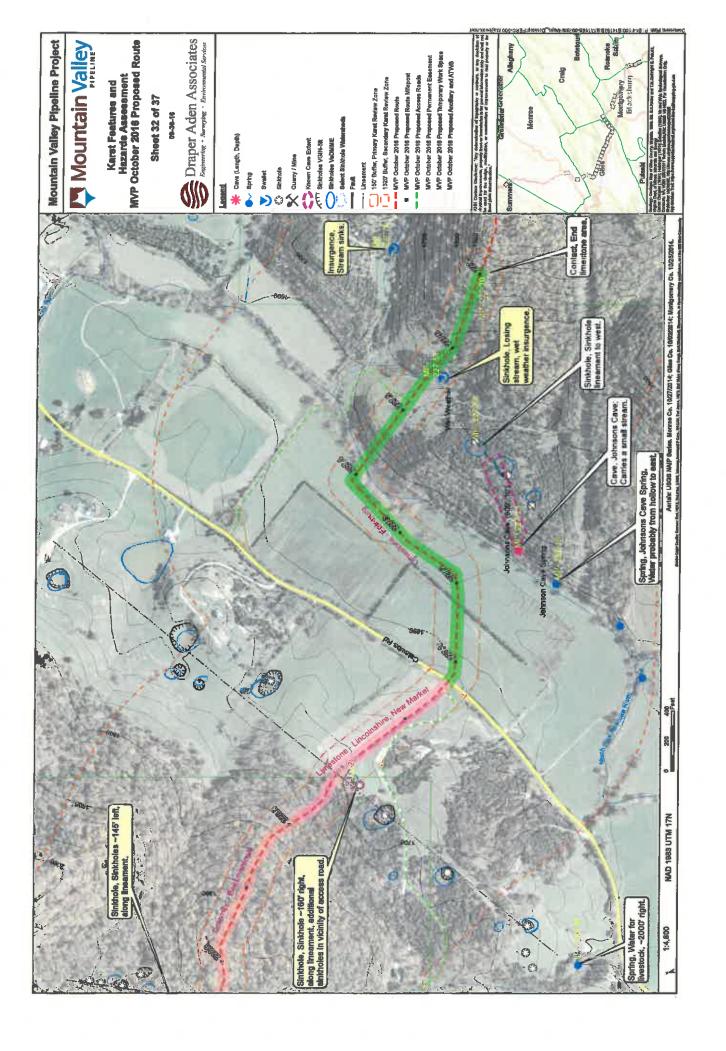


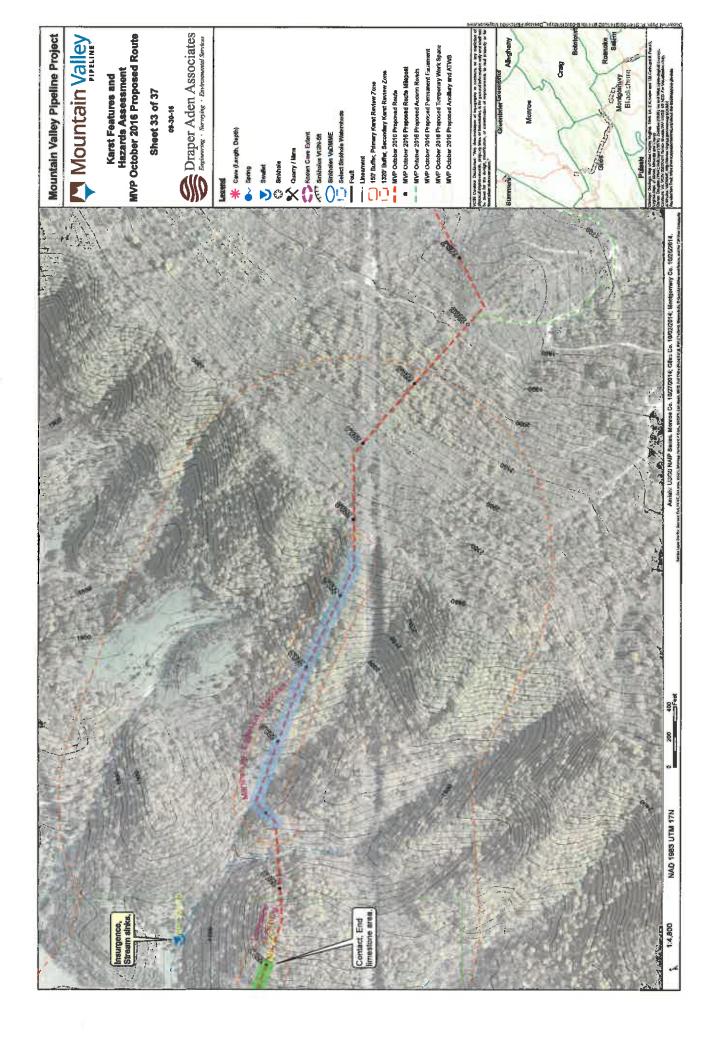


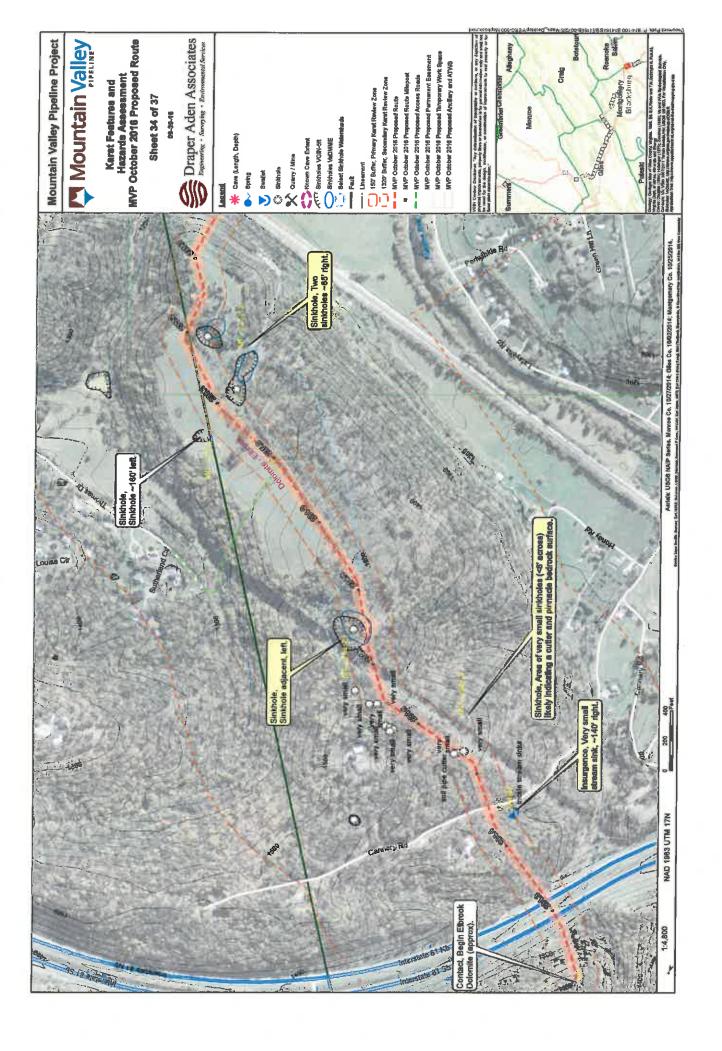


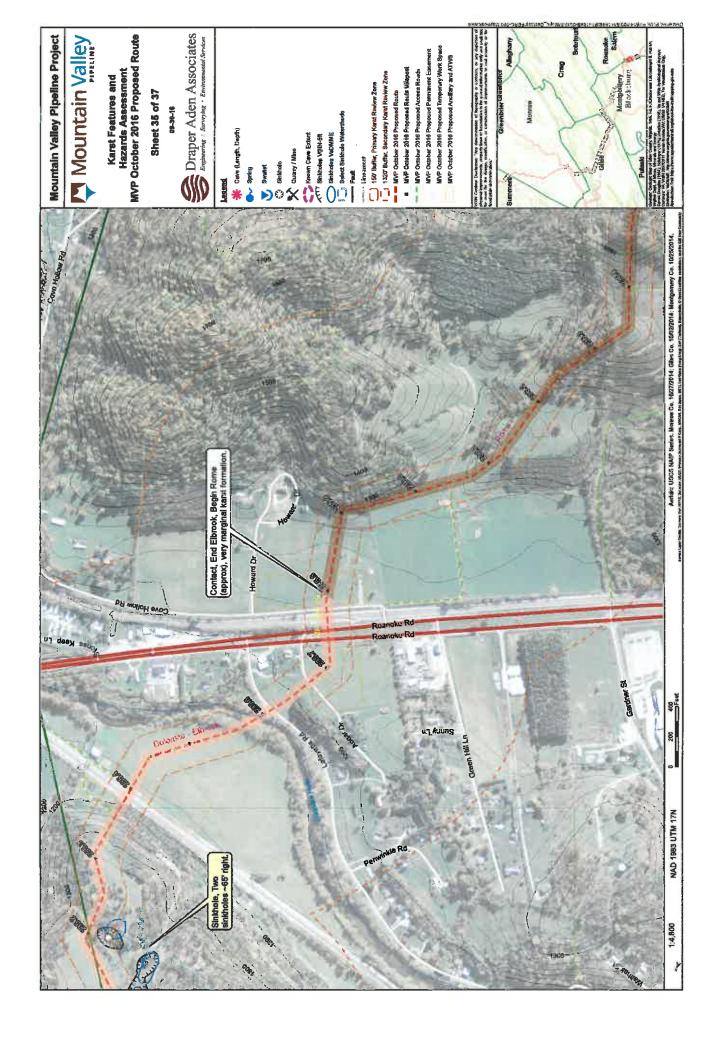


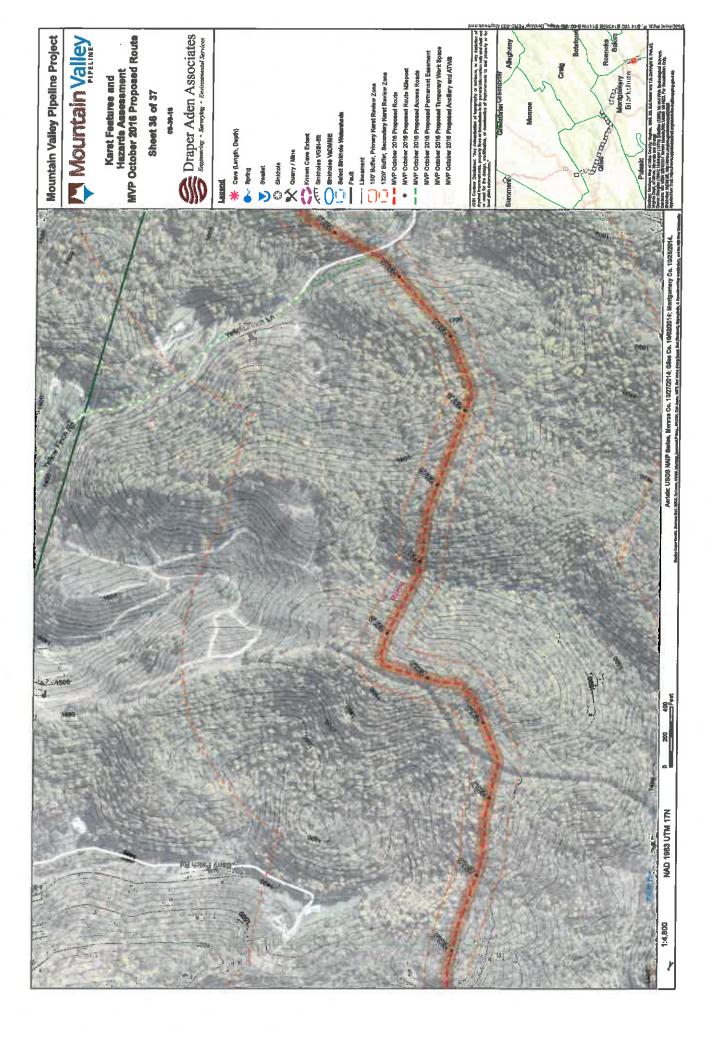


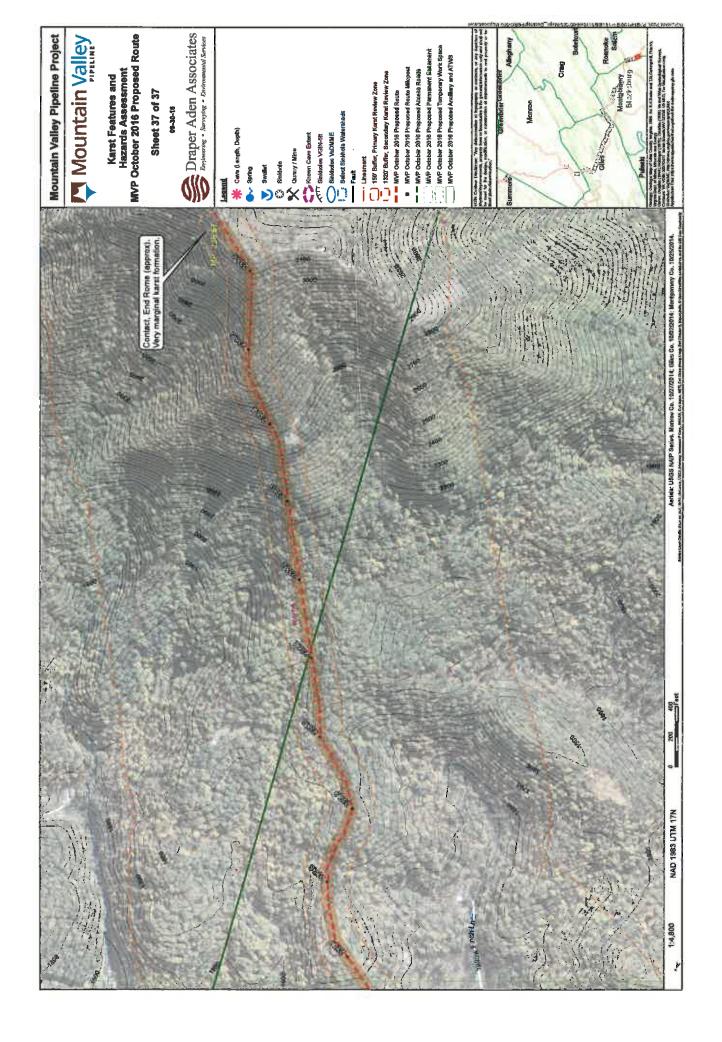












Mountain Valley Pipeline, LLC Mountain Valley Pipeline Project Docket No. CP16-10-000

Responses to FERC Post-Application Environmental Information Request #3 Dated June 28, 2016

Request:

General Project Description

3. Mountain Valley's April 21, 2016 responses to our March 31, 2016 EIR RR2 No. 12 and RR6 No. 4 were incomplete. File the results of a fracture trace/lineament analysis utilizing remote sensing platforms (aerial photography and LiDAR). Provide the results of this analysis on a composite map, illustrating surficial karst features with the potential for intersecting shallow interconnected karst voids and cave systems over a wide area; specifically between the pipeline and nearby water receptors (public water supply wells and municipal water supplies, private wells, springs, discharge to surface water, and recharge areas).

Response Submitted July 12, 2016:

Mountain Valley expects to file by August 19, 2016 a composite map that illustrates apparent lineament features, surficial karst features, the proposed alignment, and nearby water receptors (public water supply wells and municipal water supplies, private wells, springs, discharge to surface water, and recharge areas).

Supplemental Response Submitted October 13, 2016

A fracture trace is the depiction of linear land-form features based on inspection of aerial photographs or images and/or remotely sensed digital data. An apparent fracture trace typically refers to a linear landform feature less than one mile in length, while a lineament is commonly referenced as a linear feature greater than one mile in length. These linear landform features may be observed as changes in vegetative growth, sharp changes in stream channel direction, or alignment of stream valley or drainage patterns that may be indicative of enhanced weathering of bedrock at the Earth's surface where it intersects a fracture, joint, fault, major bedding plane, etc. A fracture trace analysis is one of a variety of tools that may be employed to identify karst feature distribution and potential influences on groundwater flow rate and direction.

The potential geologic origins of fracture traces and lineaments are discussed in Lattman (1958) and Lattman and Parizek (1964). From Diadoto (1999):

Lineaments and fracture traces can be evidence of zones of permeability contrast relative to the neighboring rock mass. In the case in which they are zones of enhanced permeability, they may preferentially conduct groundwater. Alternatively, where weathering in zones of fracture concentration in relatively permeable parent rocks leads to formation of clays in situ, reduced permeability may result. In that case, zones of fracture concentration create impediments to groundwater flow. Zones of fracture concentration in soluble rocks such as carbonates can lead to enhanced dissolution of these rocks due to accelerated chemical and physical weathering. In carbonate rocks where karstification occurs,

Mountain Valley Pipeline, LLC Mountain Valley Pipeline Project Docket No. CP16-10-000

Responses to FERC Post-Application Environmental Information Request #3 Dated June 28, 2016

the alignment of sinkholes can be diagnostic. However, the occurrence of sinkholes along mapped fracture traces and at fracture trace intersections is taken as supplemental independent evidence of the occurrence of a zone of enhanced permeability.

There are no publicly-available remote sensing data, including LIDAR, for the karst areas of the October 2016 Proposed Route. Mountain Valley collected LIDAR data along a narrow corridor corresponding to the October 2016 Proposed Route centerline. These data are useful for designing the alignment and easements, but the data are not distributed over an appropriate scale to allow for fracture trace analysis relative to wells and springs in the vicinity. For the fracture trace analysis presented here, digital elevation terrain model data were evaluated.

Draper Aden Associates (Mountain Valley's Karst Specialist Team) conducted a fracture trace analysis to identify apparent fracture traces that may represent enhanced secondary porosity in bedrock between the proposed alignment and a water well or spring. Prior to conducting the fracture trace analysis, Mountain Valley identified karst features within 0.25-mile of the October 2016 Proposed Route, and water supplies within 500 feet of the alignment in karst terrain.

The results of the fracture trace analysis are depicted on the map attached as Attachment DR3 General-3. Terrain model data for Virginia were taken from the Commonwealth of Virginia, Virginia Geographic Information Network (VGIN), Virginia Basemap Program. Terrain model data for West Virginia were taken from U.S. Geological Survey (USGS) 1/9 National Elevation Dataset (NED), 3-meter Digital Elevation Model created from West Virginia Statewide Addressing and Mapping Board (SAMB) Digital Terrain Model. The October 2016 Proposed Route is shown as a red dashed line with pink-highlighted sections designating where the proposed alignment is underlain by karst-forming carbonate bedrock. Wells and springs are shown and referenced in the legend. Fault traces (black lines in the attachment) represent the inactive ancient thrust faults inherent to the karst areas of the Eastern Plateau and Valley and Ridge geologic provinces, which were taken from digital data published by the Virginia Department of Mines, Minerals and Energy (VDMME, 2003). Green lines are county jurisdictional boundaries. Apparent fracture traces are shown as orange lines where they intersect the October 2016 Proposed Route. Most are consistent with the range of observed bedrock strike in the vicinity of the proposed alignment (i.e., generally north 60-degrees east), with an approximately orthogonal set of apparent fracture traces also observed.

Complex structural geology of the eastern Appalachian Plateau and the Valley and Ridge geologic provinces resulted from ancient tectonic folding and faulting. The bedrock structure in the vicinity of the October 2016 Proposed Route has resulted in unconformable lithology contacts over relatively short horizontal distances. For example, the Karst Specialist Team observes that carbonate bedrock in fault-contact with siliciclastic (sandstone and shale) bedrock results in relatively intense karst formation that controls groundwater flow rate and direction. Given those structural and lithologic complexities, coupled with a temperate climate averaging more than 40

Mountain Valley Pipeline, LLC Mountain Valley Pipeline Project Docket No. CP16-10-000

Responses to FERC Post-Application Environmental Information Request #3 Dated June 28, 2016

inches of annual precipitation, it is the Karst Specialist Team's opinion that karst hydrogeology dominates groundwater flow rate and direction in the vicinity of the October 2016 Proposed Route underlain by karst terrain. The Karst Specialist Team interprets apparent fracture traces to exert less control on groundwater flow rate and direction than these dominant lithologic and tectonic factors.

In conclusion, prior to conducting the fracture trace analysis, Mountain Valley completed a detailed desktop analysis identifying karst features within 0.25-mile of the proposed alignment and alternatives, and is in the process of confirming these features by direct field observation. Mountain Valley is also identifying wells and springs within 150 feet of the entire alignment, expanded to 500 feet in karst terrain for baseline testing. Mountain Valley understands that apparent fracture traces can provide some level of enhanced predictive capability for mapping karst features and groundwater flow; however, lithology variations and karst geomorphology in the temperate climate of the Appalachian Mountains are the primary drivers for groundwater flow. Mountain Valley has employed a robust process for identifying and evaluating karst features and water supplies that accounts for apparent fracture traces. Mountain Valley will continue to initiate proactive measures to protect water supply quality and quantity along the entire October 2016 Proposed Route, including karst terrain.

References

Diodato, D.M., 1999. Fracture Trace Mapping of the Eldridge-Wilde Well Field, Pinellas County, Florida. U. S. Geological Survey, Open-File Report 99-235, U.S. Department of the Interior, Reston, Virginia.

Lattman, L.H., 1958, Technique of mapping geologic fracture traces and lineaments on aerial photographs, Photogrammetric Eng., v. 24, p. 568.

Lattman, L.H., and R.R. Parizek, 1964, Relationship between fracture traces and the occurrence of ground water in carbonate rocks: Journal of Hydrology, v. 2, p. 73.

VDMME, 2003. Digital Representation of the 1993 Geologic Map of Virginia, 2003: https://www.dmme.virginia.gov/commerce/

Respondent: Ricky Myers Position: Engineering Manager Phone Number: 724-873-3640



March 22, 2016

Mr. Anthony Cario
Virginia Department of Environmental Quality
Surface Water Withdrawal Permitting
269 East Main Street
Richmond, VA 23219

Subject:

Hydrostatic Test Water Withdrawal

Mountain Valley Pipeline

Dear Mr. Cario,

Mountain Valley Pipeline (MVP) is a joint venture between EQT Midstream Partners, LP and affiliates of NextEra Energy, Inc., Con Edison Gas Midstream, LLC, WGL Holdings, Inc., Vega Energy Partners, Ltd., and RGC Midstream, LLC. MVP is proposing to construct and operate a natural gas pipeline 301-miles in length and 42-inches in diameter in order to provide timely and affordable access to the growing demand for natural gas. Providing up to 2.0 million dekatherms of natural gas per day, this pipeline will allow for the sale of natural gas to local distribution companies (LDCs), industrial users, and power generation facilities in the Mid-Atlantic and southeastern markets, as well as other potential markets in the Appalachian region.

The proposed Project will span 11 counties in West Virginia and six counties in Virginia. The proposed pipeline route will begin at the existing Equitrans, L.P. transmission system near the Mobley processing facility in Wetzel County, West Virginia and extend to the Transco Zone 5 compressor station 165 in Transco Village, in Pittsylvania County, Virginia. In addition to the pipeline, the Project will include three compressor stations currently planned along the route in West Virginia, as well as other ancillary facilities that are required for the safe and reliable operation of the pipeline.

MVP is seeking your guidance regarding hydrostatic pressure testing of 105 miles of natural gas pipeline and associated surface water withdrawals in the Commonwealth of Virginia. To assist with your understanding, the following information has been prepared for your review: mapping of proposed withdrawal and discharge locations, and table indicating proposed water source, anticipated volume requirements, maximum withdrawal rates, and proposed water budgeting. MVP is also requesting guidance on the withdrawal of an additional 5,000 gallons of surface water per construction spread (less than 5,000 gallons per day) from those same withdrawal locations for the purpose of dust suppression during project construction.

MVP is requesting confirmation that, in accordance with Virginia Code 9VAC25-210-60, proposed surface water withdrawals for our purposes of hydrostatic pressure testing and dust suppression will be excluded from Virginia Water Protection permit requirements.

Mr. Anthony Cario March 22, 2016 Page 2 of 2

If you have any questions regarding the attached documents, please feel free to contact me at (412) 395-5583 or at ddurofchalk@eqt.com.

Sincerely,

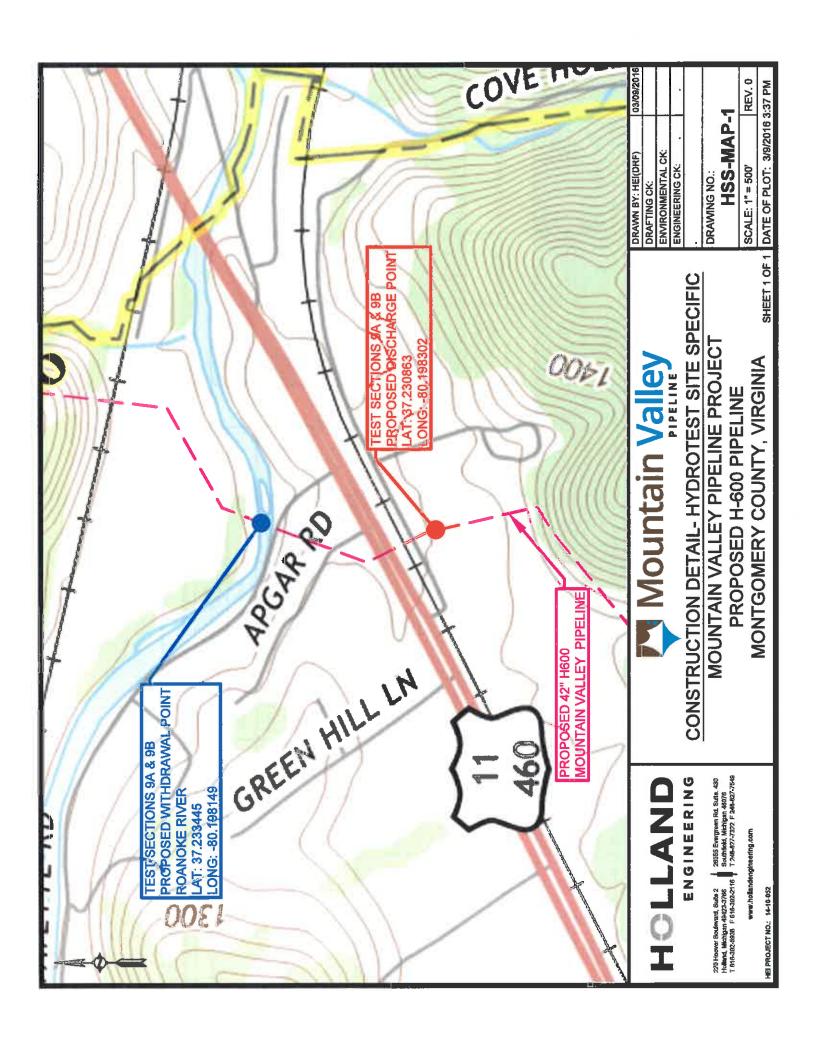
David J. Durofchalk

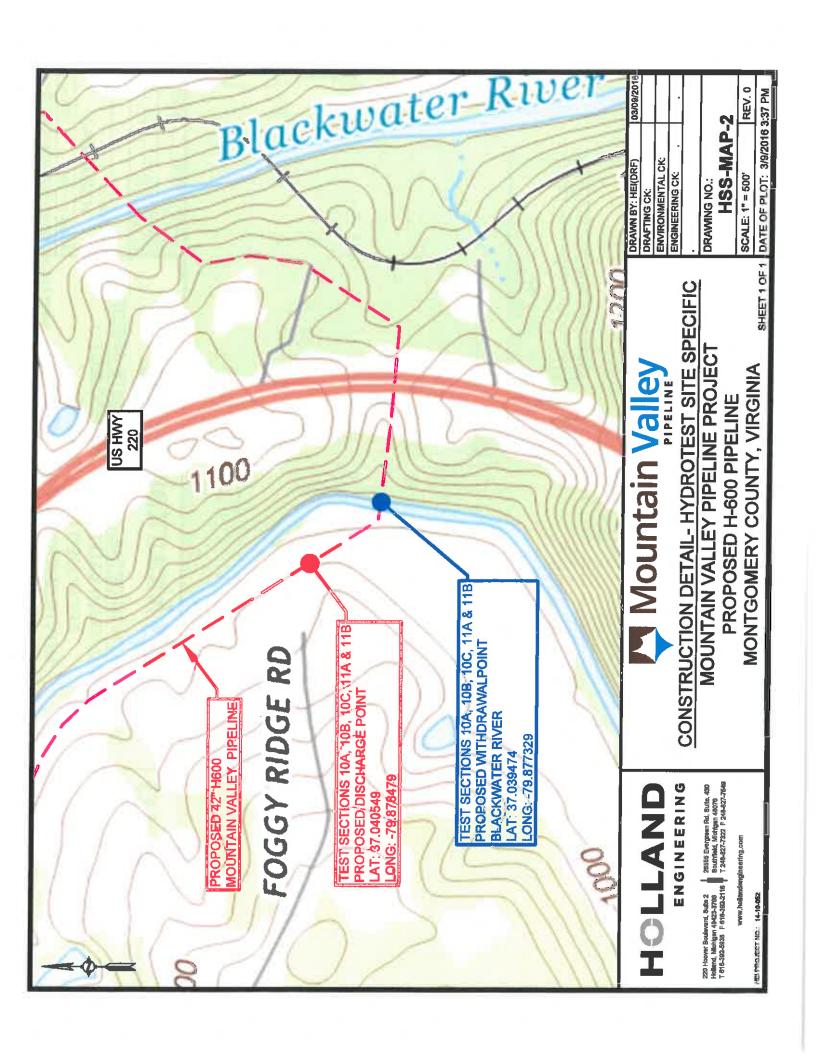
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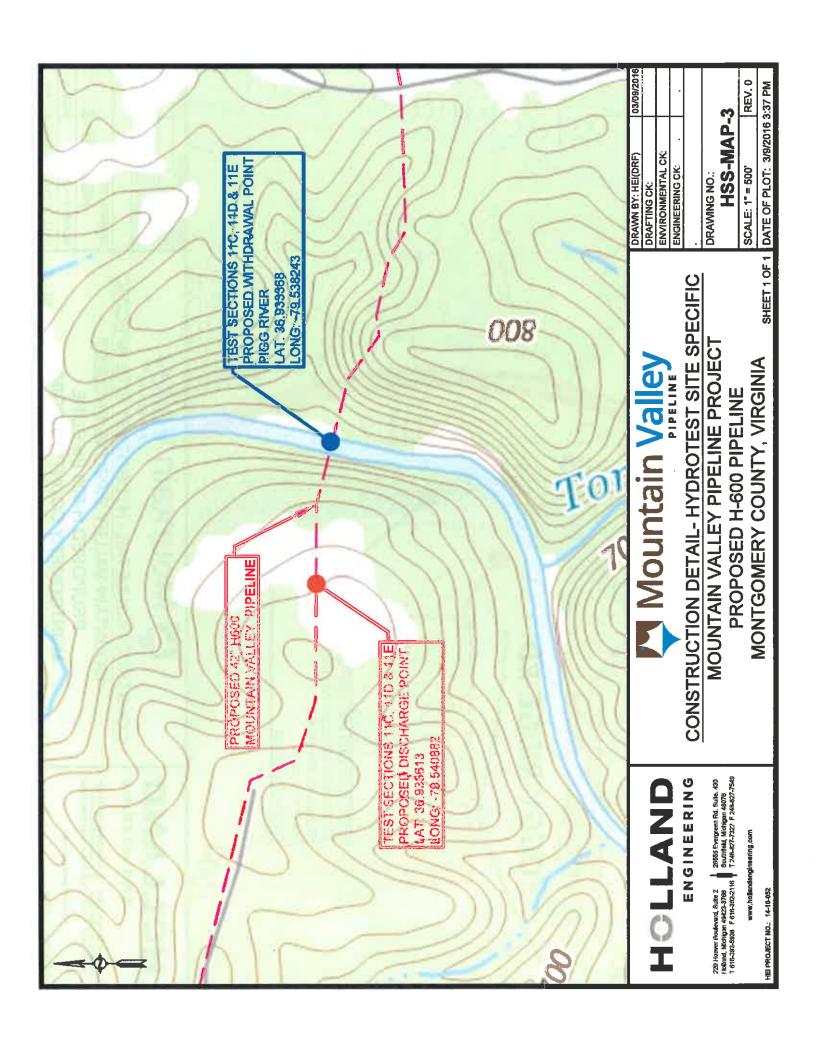
Senior Environmental Coordinator

					Proposed Hydrostatic Test Water Use Summary	static Test Wa	ter Use Sumn	nary					
Construction Spread	lon Segment Nата	11 Beginning MP	Ending	Length of Section	Required Water (gal)	Maximum Anticipated Withdrawal Rete (gpm)	Percentage of Daily Average Flow		Proposed Water Source	Source	Propos	Proposed Test Water Discharge Location	Proposed Withdrawal/ Discharge Month
								MP	Proposed Water Source	Anticipated Flow (Sep.	œ	Volume	
	V60	204.7	218.1	13.4 mi	4,796,936 gal				Roanoke River				
თ	09B	218.1	234.0	15.9 mi	5,691,886 gal	1,500 gpm	2.07%	233.8	Section 9A + Roanoke River	72,593 gpm	234.0	5,691,886 gal	Oct-Nov 2018
	10A	234.0	247.1	13.1 mi	4,689,542 gal	1,500 gpm	3.18%		Blackwater				
10	10B	247.1	256.9	9.8 mi	3,508,207 gal			262.8	Reuse from Test Section	47,124 gpm	262.7	4,689,542 gal	Oct-Nov
	100	256.9	262.7	5.8 mi	2,076,286 gal				Reuse from Test Section				7010
	114	262.7	267.3	4.6 ші	1,646,709 gal	1,500 gpm	3.18%	262.8	Section 11B + Blackwater River	47.124 dpm	262.7	1 848 700 mal	
-	118	267.3	270.0	2.7 mi	966,547 gal				Blackwater River			3	
	11C	270.0	286.2	16.2 mi	5,799,281 gai	1,500 gpm	1.06%		Section 11D + Pigg River				2018
	11D	286.2	295.1	8.9 mi	3,186,025 gal			286.3	Section 11E +	141,709 gpm 286.2	286.2	5,799,281 gal	
	11E	295.1	301.0	5.87 mi	2,101,344 gal				Pigg River				
M pesodo	Proposed Water Usage for Virginia (only bold quantities): 17	or Virginia (or	ily bold qu	iantities):	17,827,418 gal								

"Dally average flow for streams obtained by calculating the average daily output of the above streams for the months of September through December over their entire recording history as made available by USGS.









March 22, 2016

Mr. Kip Foster
Virginia Department of Environmental Quality
Blue Ridge Region, Roanoke Office
3019 Peters Creek Road
Roanoke, VA 24019

Subject:

Hydrostatic Test Water Discharge

Mountain Valley Pipeline

Dear Mr. Foster,

Mountain Valley Pipeline (MVP) is a joint venture between EQT Midstream Partners, LP and affiliates of NextEra Energy, Inc., Con Edison Gas Midstream, LLC, WGL Holdings, Inc., Vega Energy Partners, Ltd., and RGC Midstream, LLC. MVP is proposing to construct and operate a natural gas pipeline 301-miles in length and 42-inches in diameter in order to provide timely and affordable access to the growing demand for natural gas. Providing up to 2.0 million dekatherms of natural gas per day, this pipeline will allow for the sale of natural gas to local distribution companies (LDCs), industrial users, and power generation facilities in the Mid-Atlantic and southeastern markets, as well as other potential markets in the Appalachian region.

The proposed Project will span 11 counties in West Virginia and six counties in Virginia. The proposed pipeline route will begin at the existing Equitrans, L.P. transmission system near the Mobley processing facility in Wetzel County, West Virginia and extend to the Transco Zone 5 compressor station 165 in Transco Village, in Pittsylvania County, Virginia. In addition to the pipeline, the Project will include three compressor stations currently planned along the route in West Virginia, as well as other ancillary facilities that are required for the safe and reliable operation of the pipeline.

MVP is seeking your guidance regarding hydrostatic pressure testing of 105 miles of natural gas pipeline and associated surface water discharges in the Commonwealth of Virginia. To assist with your understanding, the following information has been prepared for your review: mapping of proposed withdrawał and discharge locations, and table indicating proposed test water discharge location by watershed, anticipated discharge volumes, discharge rate, and proposed water budgeting.

MVP is requesting confirmation that, in accordance with Virginia Code 9VAC25-120-70, owners of proposed hydrostatic pressure testing of pipelines are exempt from submitting a registration statement for coverage under the general VPDES permit.

If you have any questions regarding the attached documents, please feel free to contact me at (412) 395-5583 or at ddurofchalk@eqt.com.

Sincerely,

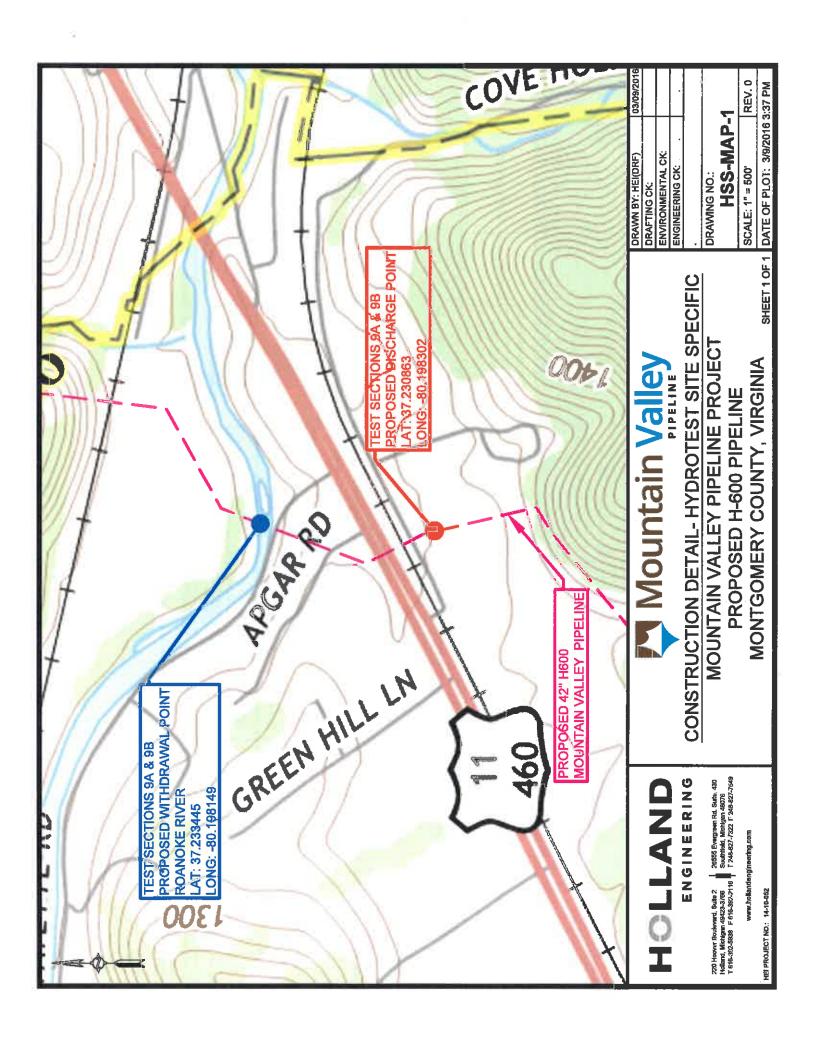
David J. Durofchalk

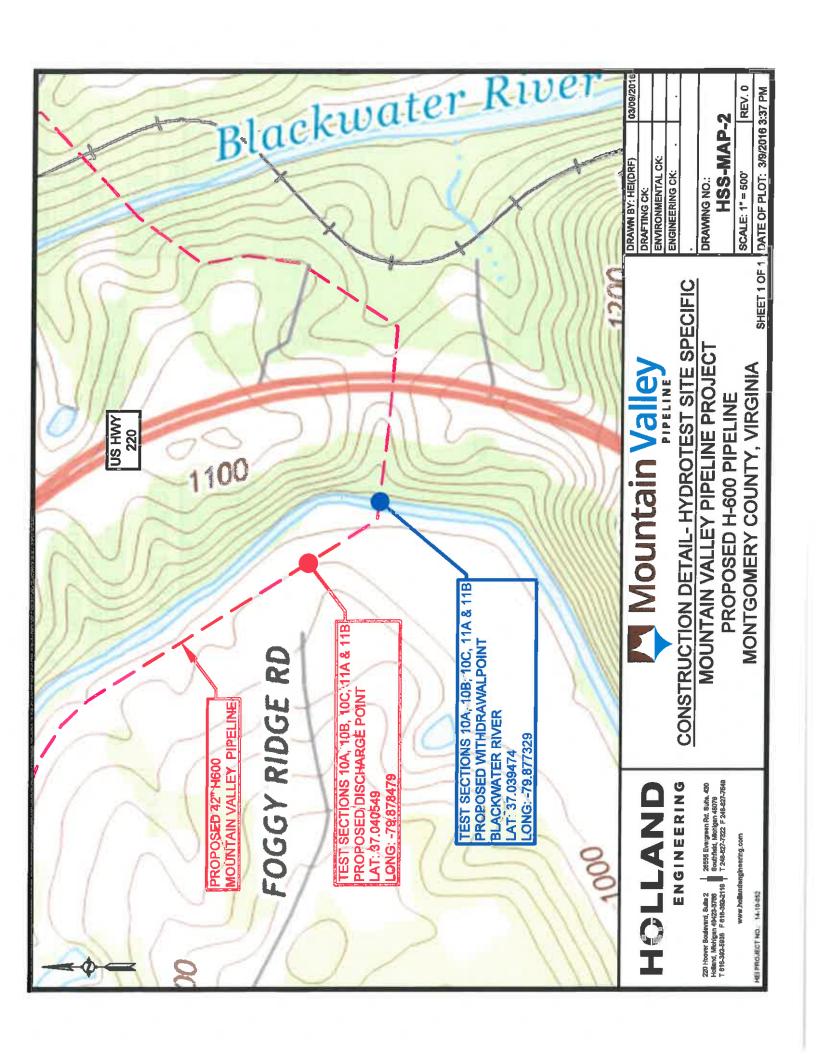
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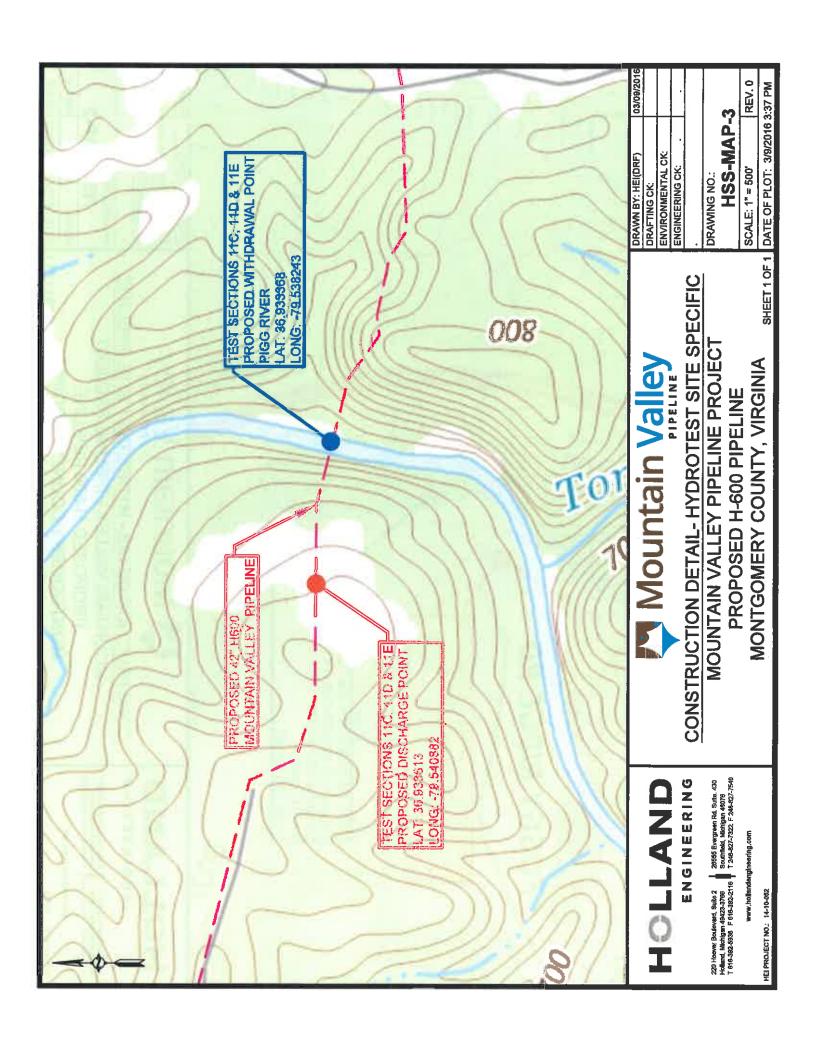
Senior Environmental Coordinator

	Proposed Withdrawa / Discharge Month			Oct-Nov 2018		Oct-Nov			50	2018			
	Proposed Test Water Discharge Location	Volume		234.0 5,691,886 gal		4,689,542 gal		262 7 1 648 709 na			5,799,281 gal		
	Propos	NP.		234.0		262.7		7627			286.2		
	Source	Anticipated Flow (Sep - Dec)		72,593 gpm		47,124 gpm		47.124 apm			141,709 gpm 286.2		
	Proposed Water Source	Proposed Water Source	Roanoke River	Section 9A + Roanoke River	Blackwater River	Reuse from Test Section 10A	Reuse from Test Section	Section 11B + Blackwater River	Blackwater River	Section 11D + Pigg River	Section 11E + Pigg River	Pigg River	
yary		MP		233.8		262.8		262.8			286.3		
ter Use Summ	Percentage of Daily Average Flow			2.07%	3.18%			3.18%		1.06%			
tatic Test Wa	Maximum Anticipated Withdrawal Rate (gpm)			1,500 gpm	1,500 gpm			1,500 gpm		1,500 gpm			
Proposed Hydrostatic Test Water Use Summary	Required Water (gal)		4,796,936 gal	5,691,886 gal	4,689,542 gal	3,508,207 gal	2,076,286 gal	1,646,709 gal	966,547 gal	5,799,281 gal	3,186,025 gal	2,101,344 gal	17 827 418 nal
	Length of Section		13.4 mi	15.9 mi	13.1 mi	9.8 mi	5.8 mi	4.6 ті	2.7 mi	16.2 mi	8.9 mi	5.87 mi	antilles):
	Ending		218.1	234.0	247.1	256.9	262.7	267.3	270.0	286.2	295.1	301.0	/ bold aux
	Beginning MP		204.7	218.1	234.0	247.1	256.9	262.7	267.3	270.0	286.2	295.1	Virginia (only
	Segment		09A	09B	10A	10B	10C	114	11B	110	11D	11E	Usage for
	Construction Spread			တ		10			Ţ	:			Proposed Water Usage for Virginia (only bold quantifies):
	Anticipated Year of Construction			2018		2018			a100	2007			-

*Daily average flow for streams obtained by calculating the average daily output of the above streams for the months of September through December over their entire recording history as made available by USGS.







		Mountain Va	lley Project	Equitrans Expar	sion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
Federal	<u> </u>				
FERC	Certificate under Section 7 of the NGA	October 23, 2015 application filed with the FERC	Pending	October 27, 2015 application filed with the FERC	Pending
BLM	Right-of-way Grant for COE and FS lands	April 5, 2016Pending	Pending	N/A	N/A
ACHP	Comment on undertakings under Section 106 of the NHPA	Pending	Pending	Pending	Pending
USDA FS Jefferson National Forest	Survey permission under the Forestwide Standard, FW- 244	November 2014, March 2015, August 2015 September 22, 2016	Pending	N/A	N/A
	Consideration of the Right-of-Way Grant and Temporary Use Permit under Section 28 of the Mineral Leasing Act Cooperating Agency for EIS under Section 204 of NEPA	April 5, 2016Pending	Pending	N/A	N/A
	LRMP Amendments				
	Regional Forester's Sensitive Species viability determinations				

		Mountain Va	lley Project	Equitrans Expa	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
	ROD for Forest Plan Amendments under the National Forest Management Act	January 22, 2016 filed Right of Way Grant application & PODPending	Pending	NA	NA
COE Huntington District, Norfolk District,	Section 404 of CWA & Section 10 of RHA permits	February 21-24, 2016	Pending	October 2015	Pending
Pittsburgh District	Joint Permit Application	N/A	N/A	June 2016	Pending
USDOI - FWS	Section 7 of ESA, BGEPA, and MBTA Consultations	Consultation Initiated September 2014	Pending	Consultation Initiated June 24, 2015	Pending
USDOI – NPS ANST Office Blue Ridge Parkway Office	Right-of-way Grant to cross the Blue Ridge Parkway under the Energy Policy Act of 2005; 36 CFR 14; 16 USC5; 16 USC 79; NEPA	Applications Pending	Pending	N/A	N/A
	Survey permission	November 2015, October 17, 2016	Pending	N/A	N/A
DOT - PHMSA and Office of Safety, Energy, and the Environment	Consultation	Consultation Initiated October 2014	N/A	Consultation Initiated April 27, 2015	N/A

		Mountain Va	iley Project	Equitrans Expai	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
State of West Vi	rginia		·		
West Virginia Division of Culture and History	Section 106 NHPA Consultations	August 12, October 12, & December 24, 2015 & February 24, April 21, June 136, & July 8, 2016 reports submitted	October 6 & November 16, 2015 & January 27, February 12, March 22, April 4, -&-May 2, & July 14, August 15, 2016 SHPO comments	February 5, 2016 survey reports submitted	Pending
WVDEP, Division of Air Quality	CAA permit for air emissions for the Bradshaw, Harris, and Stallworth Compressor Stations	Application filed October 21, 2015	PendingApproved March 4, 2016, March 13, 2016, and April 11, 2016	N/A	N/A
WVDEP, Division of Water and Waste Management	Section 401 CWA Water Quality Certification	Application filed February 25, 2016	Pending	N/A	N/A
	Section 402 CWA NPDES Permit – Construction Stormwater General Permit for Oil and Gas Related Construction Activities	Application filed February 23, 2016	Pending	Application Pending	Pending
	Section 402 CWA NPDES Hydrostatic Test Discharge Permit	Application filed October 2016Pending	Pending	Application Pending	Pending
	Natural Streams Preservation Act	Pending	Pending	N/A	N/A

		the Frequency		<u> </u>	
·		Mountain Va	lley Project	Equitrans Expa	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
WVDNR, Office of Land and Streams	Permit for construction in or across a stream under WV Code Chapter 5A, Article 11	Application filed second quarter 2016	Pending	Application Pending	Pending
West Virginia Department of Transportation	Road Crossings & Encroachment Permits under Section 6, Article 16, Chapter 17; Section 9, Article 16, Chapter 17; Section 8, Article 4, Chapter 17, West Virginia Code 1931	Application filed second quarter 2016	Pending	Application Pending	Pending
State of Virginia					
VDEQ – Water Division	Section 401 CWA – Water Quality Certificate	N/A – issued with the COE permit	Pending	N/A	N/A
	Section 402 CWA NPDES Permit – Construction Stormwater General Permit	February 11, 2016, June 27, 2016	Pending	N/A	N/A
	Section 402 CWA NPDES Hydrostatic Test Withdrawal Permit (Permit 9VAC25-200-10)	Consultation Initiated on March 22, 2016	N/A	N/A	N/A
	Section 402 CWA NPDES Hydrostatic Test Discharge Permit (General Permit VAG83)	Consultation Initiated on March 22, 2016	N/A	N/A	N/A

		Mountain Va	liley Project	Equitrans Expan	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
VDGIF	Consultations on impacts on state-managed lands under FWS Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.)	Consultation Initiated on March 22, 2016	N/A	N/A	N/A
Virginia Department of Historic Resources	Section 106 NHPA Consultations	August 11 & 12, September 11, 2015, October 8, & December 1, 2015, & January 14, March 10 & 15, June 7 & 24, J& July 12, 18 & 19, & August 31, 2016 reports submitted	October 22 & 27, & December 30 & 31, 2015 & January 6, February 18, April 21-, & May 25, August 4, & September 27, 2016 SHPO comments	N/A	N/A
Virginia Department of Transportation	Road bonds and crossing permits under Code of Virginia 33.1-12	Application filed second quarter 2016	Pending	N/A	N/A
Virginia Marine Resources Commission	Submerged Lands License under Virginia Administrative Code 4 VAC 20- 120-10 ET SEQ.	February 24 , 2016	Pending	N/A	N/A
Virginia Department of Forestry	Consultations	Consultation Initiated on October 13, 2014	N/A	N/A	N/A
Virginia Department of Conservation and Recreation	Consultations regarding wildlife species/habitat, state-managed lands, and state parks	Consultation Initiated on October 13, 2014	N/A	N/A	N/A

	_	Mountain Va	lley Project	Equitrans Expan	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticlpated)	Receipt Date (Anticipated)
Virginia Outdoors Foundation	Conversion/Dive rsion of Open Space Access or Utility Easement Application under Virginia Code Section 10.1-1704	January 22, 2016	Pending	N/A	N/A
State of Pennsyl	vania				
Pennsylvania Historical and Museum Commission, Bureau for Historic Preservation	Section 106 NHPA Consultations	N/A	N/A	February 5, 2016 survey reports submitted	Pending
Pennsylvania Department of Conservation and Natural Resources	ESA Consultations	N/A	N/A	Consultation Initiated on June 24, 2015	Pending
Pennsylvania Department of Environmental Protection (PADEP), Air Permits Division	Chapter 127 Minor Source Permit Title V or Minor Source Operating Permit under CAA	N/A	N/A	October 2015	Pending

		Mountain Va	illey Project	Equitrans Expa	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
PADEP	ESCGP-2; General Permit for Earth Disturbance Associated with Oil and Gas Exploration, Production, Processing, or treatment operations or transmission facilities under 25 Pa. Code 102.5 (c) and (m)	N/A	N/A	March 2016	Pending
	PAG-10 General Permit; Hydrostatic Testing of Tanks and Pipelines under CWA	N/A	N/A	Consultation initiated on April 27, 2015; Statewide PAG-10 authorization held. Permit Application Filed – March 2016	N/A
PADEP, Division of Waterways, Wetlands, and Stormwater Management	Chapter 105 Water Obstruction and Encroachment Permit; CWA Section 401 Water Quality Certification (jointly with COE Section 404) Submerged Lands License Agreement	N/A	N/A	October 2015	Pending
Pennsylvania Fish and Boat Commission	ESA Consultations	N/A	N/A	Consultation Initiated on June 24, 2015	Pending

-	· ·	Mountain Va	lley Project	Equitrans Expa	nsion Project
Agency	Permit/ Consultation	Submittal Date (Anticipated)	Receipt Date (Anticipated)	Submittal Date (Anticipated)	Receipt Date (Anticipated)
Pennsylvania Game Commission	ESA Consultations	N/A	N/A	Consultation Initiated on June 24, 2015	Pending
Pennsylvania Department of Transportation	Highway Occupancy Permit under Sections 411 and 420 of the State Highway Law	N/A	N/A	Application Pending	Pending
N/A = Not applicable					

ATTACHMENT 3.0 KARST MITIGATION PLAN

Prepared For:



Mountain Valley Pipeline Suite 1700 625 Liberty Avenue Pittsburgh, PA 1522-3111

October 5, 2015

Prepared By:



DAA Project Number: B14188B-01

Draper Aden Associates (DAA) prepared this document (which may include drawings, specifications, reports, studies and attachments) in accordance with the agreement between DAA and MVP Gathering, LLC.

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Conclusions presented are based upon a review of available information, the results of our field studies, and/or professional judgment. To the best of our knowledge, information provided by others is true and accurate, unless otherwise noted.

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3.0 KARST MITIGATION PLAN

This Karst Mitigation Plan addresses the assessment and mitigation of potential hazards associated with land disturbance in karst terrain to support Mountain Valley Pipeline (MVP) construction. Hazards include the potential to impact sensitive karst features during construction, as well as potential hazards presented to pipeline construction and operation associated with karst terrain.

Karst feature assessment and mitigation efforts that are covered in this plan will take place within the limits of land disturbance (LOD) along the MVP alignment that is underlain by karst terrain. The LOD is identified in this Plan as an area within the MVP construction easement where ground cover is removed or where the grade is altered, through MVP construction activities (clearing and grubbing, trenching, blasting, boring or drilling). It is noted that MVP does not plan to utilize horizontal directional drilling (HDD) in karst terrain.

Karst terrain occurs from southern Summers County, West Virginia into Roanoke County, Virginia along an approximately 33 mile corridor within which the proposed MVP alignment is proposed for construction (Figure 3.1). Note that karst terrain is not continuous throughout the karst zone illustrated in Figure 3.1. The Appalachian Plateau and Valley and Ridge geologic provinces are characterized by Mississippian to Ordovician age sedimentary bedrock, with folding and ancient thrust faulting resulting in a complicated distribution of rock types through this region. Siliciclastic sedimentary bedrock that does not form karst terrain is interbedded, or otherwise in contact with karst-forming carbonate bedrock.

The Karst Hazards Assessment (provided under separate cover) for the proposed MVP alignment in karst terrain included a desk top review using public and proprietary data sources extending a minimum of 0.25-mile from either side of the proposed MVP alignment and alternate routes. A more detailed assessment was made through field confirmation of karst features within a minimum of 150 feet from the proposed MVP alignment on parcels where landowner permission was granted to access the property.

Avoidance of a karst feature constitutes the first and foremost recommendation for mitigating impact. If an identified karst feature cannot be reasonably avoided, or if a previously unidentified

karst feature is encountered or forms during construction, this **Karst Mitigation Plan** provides recommendations for impact mitigation and feature stabilization.

MVP will deploy a Karst Specialist (KS) prior to, and during construction to confirm, monitor, and mitigate if necessary, existing karst features, and to assess and mitigate previously unidentified karst features that are encountered or observed to form during MVP land disturbance and construction.

3.1 Regulatory Framework

Land disturbance for natural gas pipeline construction and installation constitutes a construction practice that is regulated under federal and state laws for stormwater management and erosion and sediment control (ESC). Construction within karst terrain carries additional regulations to protect caves. The following summarizes the regulatory programs currently in-place in Virginia and West Virginia that will apply to pipeline construction in karst terrain.

In Virginia, ESC is governed by the Erosion & Sediment Control Law (§62.1-44.15:51 et seq) and the Erosion & Sediment Control Regulations (9VAC25-840) and falls under the purview of the Virginia Department of Environmental Quality (DEQ). Note that effective July 2, 2013, DEQ assumed stormwater permitting responsibilities from the Virginia Department of Conservation and Recreation. These laws and regulations serve to let the State regulate construction ESC in compliance with the Clean Water Act NPDES Permit program. Specifically, construction stormwater discharges are covered by the General VPDES permit for discharges of stormwater from construction activities, which requires that the Erosion Control/Stormwater regulations are followed for applicable sites. In normal cases, Erosion & Sediment Control regulations are triggered if land disturbance exceeds 10,000 square feet, and stormwater regulations are triggered if land disturbance exceeds one acre.

West Virginia also administers stormwater general permits through the West Virginia Department of Environmental Protection (DEP). Activities that disturb more than one (1) acre but less than three (3) acres are required to comply with the terms of the General Permit by completing a "Notice of Intent" form, while projects disturbing greater than three (3) acres must submit a site registration application form. For projects disturbing between three (3) and 99 acres, the form must be submitted to DEP at least 60 days prior to starting the project. Sites disturbing 100 acres or more, discharge to Tier 3 waters, have an initial grading construction phase of one (1) year or greater, or a common plan of development greater than 10 acres must submit the form at least 100 days prior to starting the project.

Virginia codified a law for protecting caves (the Virginia Cave Protection Act, Code of Virginia Section 10.1-1000 to 1008); there is no corresponding law that specifically protects karst.

The Virginia Department of Conservation and Recreation, a division of the Department of Environmental Quality, includes a Karst Protection Coordinator branch. Coordination with the Karst Protection Coordinator is described in more detail in this plan.

West Virginia also has a state law designed to protect caves (West Virginia Cave Protection Act, West Virginia Code - Chapter 20, Article 7A-1 through 7A-6) but does not address karst protection measures in general.

There are no specific laws or regulations governing blasting to remove shallow bedrock for pipeline trench construction. Nonetheless, a blasting plan will be prepared by the qualified blasting contractor and the Plan enforced to mitigate impacts to structures, sensitive features, and water resources in karst resulting from blasting.

3.2 Overview of Potential Karst Hazards

The term "karst" refers to a type of landform or terrain that is characterized by the presence of sinkholes, caverns, irregular "pinnacled" bedrock surface, and springs. The development of karst terrain is a result of the presence of soluble bedrock such as limestone, dolomite, marble or gypsum. Any landscape that is underlain by soluble bedrock has the potential to develop a karst terrain landform.

The most prevalent type of karst feature observed at the ground surface along the proposed MVP alignment in karst terrain (Figure 3.1) are sinkholes. Sinkholes fall into two broad categories, termed "vault-collapse" sinkholes, or "cover-collapse" sinkholes. Vault-collapse type sinkholes (i.e., where a cavern "vault" or roof has failed catastrophically) are relatively rare in karst terrain along the proposed MVP alignment. However, cover-collapse type sinkholes are more commonly observed.

Cover-collapse sinkholes typically develop by the raveling of overburden into solution channels within the bedrock mass, in which water is the transport medium for the movement of the fines. The natural raveling process is generally slow such that sinkhole development generally occurs over a long time span. However, various changes at a site can sometimes lead to the sudden and unanticipated development of sinkholes.

The most common changes that may initiate sinkhole development are:

- 1. Increase or redirection of overland or subsurface water flow paths, which accelerates the raveling of fines;
- 2. Removal of vegetation cover and topsoil (i.e., stripping and grubbing), which can reduce the cohesive strength of overburden that overlies a conduit; and
- Sudden changes in the elevation of the water table (such as drought, over-pumping of wells,
 or quarry dewatering), which removes the neutral buoyancy of the water supporting a
 conduit plug, and may result in rapid collapse.

As noted earlier, caves, pinnacled bedrock and karst springs are also observed within karst terrain underlying the proposed MVP alignment and are addressed later in this plan.

3.3 Karst Hazards Assessment

MVP deployed a Karst Specialist (KS) team to evaluate the karst terrain of southern West Virginia and southwestern Virginia through which the proposed MVP alignment will traverse. The KS team holds qualifications of, or work under the direction of, a professional geologist having direct work experience with karst hydrology and geomorphic processes. The KS team has over 70 years of combined direct field experience evaluating karst features in the vicinity of the proposed MVP alignment.

The KS team provided a detailed inventory in the Karst Hazards Assessment (provided under separate cover) of karst features within a minimum 0.25-mile of the centerline of the proposed MVP alignment and alternate routes. The KS team evaluated publicly available and proprietary karst feature data to inventory karst features. Direct field observations (where property access was granted) was used to confirm the desktop review and evaluate the terrain for additional, previously undocumented karst features.

Recommendations were provided to MVP on the locations of sensitive karst features, or areas that are particularly susceptible to karst formation but had limited mapping and field reconnaissance. For these specific karst areas, the KS team recommended that geophysical remote sensing techniques (e.g., electrical resistivity, ground penetrating radar, etc.,) be used, and if necessary invasive borings be completed, to further elucidate a karst feature or a discrete area suspected to have subsurface karst formations. In response to the karst feature assessment, MVP has made, and continues to make alignment adjustments to avoid sensitive karst areas. Alignment adjustments therefore reduce the corresponding recommendations for remote sensing and invasive boring evaluations.

The current FERC 4.0.0 alignment minimizes risks related to karst hazards. As of the date of this report, there remains field reconnaissance to be completed on properties where access is currently denied. The KS team remains confident with the overall karst assessment and recommendations provided to MVP as related to the FERC 4.0.0 alignment. At this time, additional generalized application of geophysics, borings, etc., along the proposed alignment is not considered necessary by the KS team to provide additional data that are particularly reliable or actionable.

As noted, recommendations for avoiding major karst features were provided to MVP via the Karst Hazards Assessment, and proposed alignment adjustments were made. Karst features located in the final alignment will be minor in nature and extent (e.g., cover-collapse sinkholes). These features will be confirmed and monitored by the KS team prior to and during construction (discussed below) and if necessary stabilized. Formation of a significant karst feature during construction would be monitored and evaluated by the KS. Additional site evaluation (including geophysical remote sensing and invasive borings) may be recommended by the KS to evaluate potential that the feature serves as a conduit to groundwater and if necessary to support mitigation measures (discussed later in this report).

3.4 Karst Terrain Inspection Prior to and During Construction

MVP will deploy a KS team prior to tree clearing and complete a Level 1 inspection of karst features in the LOD (see Appendix A for Karst Feature Inspection Form). The final MVP alignment for construction will have accommodated for karst feature avoidance recommendations. Therefore, a karst feature located within the LOD is likely to be minor in its extent and nature and a candidate for mitigation and stabilization prior to disturbance.

The KS will consult with MVP Construction to determine the recommended course of action prior to tree clearing in the vicinity of the feature. It is anticipated that the most common karst feature requiring mitigation for MVP construction will be cover-collapse sinkholes (discussed below). Karst feature stabilization would be completed in conjunction with recommendations from the appropriate state agency (Virginia Department of Conservation and Recreation, Karst Protection; West Virginia Department of Environmental Protection).

MVP will deploy an on-site KS team during construction activities (clearing and grubbing, trenching, blasting, boring or drilling) within karst terrain. The role of the KS is to observe construction activities to assist in limiting potential negative impacts, and to inspect, assess and if necessary mitigate karst features that are encountered or form during construction in conjunction with recommendations from the appropriate state agency (Virginia Department of Conservation and Recreation, Karst Protection; West Virginia Department of Environmental Protection).

Two or more KS will be available to conduct multiple inspections in karst terrain where MVP Construction crews may be working at different locations simultaneously.

3.5 Sinkhole Stabilization

Sinkholes are common surficial geomorphic expressions of karst terrain. If a sinkhole is located within the proposed LOD and cannot be reasonably avoided, the sinkhole will be stabilized prior to construction in accordance with recommendations provided by the KS, and in conjunction with recommendations from the appropriate state agency (Virginia Department of Conservation and Recreation, Karst Protection; West Virginia Department of Environmental Protection).

A weekly Level 1 Inspection (described below) of the stabilized feature will be completed and documented by the KS (see Appendix A for Karst Feature Inspection Form) while construction activities (clearing and grubbing, trenching, blasting, boring or drilling) are on-going within 150 feet of the feature.

Mitigation activities will be documented upon completion in a report prepared by the KS, to be delivered to MVP.

See the following sections of this report for activities to be followed under this Mitigation Plan for karst features other than sinkholes that are located within the MVP LOD.

3.6 Level 1 Inspection of a Karst Feature

A Level 1 Inspection of a karst feature will entail observation and documentation of the following ground and feature characteristics:

- 1. soil subsidence;
- 2. rock collapse;
- 3. sediment filling;
- 4. swallet (sinking stream) or notable increased surface water infiltration;
- 5. spring / seep / flooding;
- 6. cave or void space;
- 7. clogging; and/or other changes in morphology or function that might indicate potential impact to the epikarst stratum caused by the work.

The inspection will be recorded on a Karst Feature Inspection Form (Appendix A), including digital photographs, GPS coordinates and reference to the nearest MVP milepost.

If any of the representative changes listed above are observed at a karst feature, the KS will complete a Level 2 Inspection (discussed below).

3.7 Level 2 Inspection of a Karst Feature

The Level 2 Inspection will be conducted as follows, and recorded on a Karst Feature Inspection Form provided in Appendix A.

The KS will examine the suspected karst feature to identify potential connectivity to the subterranean environment and risk for impacting groundwater quality. The choice of characterization methods will be proposed to MVP by the KS, and will include any combination of (but not be limited to):

- 1. visual assessment and physical inspection;
- 2. geophysical survey;
- 3. track drill probes;
- 4. infiltration or dye trace testing; or
- 5. other techniques utilized to facilitate subsurface characterization of karst features.

If the karst feature does not appear to have connectivity to the subterranean environment and risk for impacting groundwater quality, the KS will provide MVP Construction with a recommendation on stabilization measures for the feature (see Section 3.5 of this Plan), and construction activities will continue after the feature is stabilized.

If it is determined that the feature has connectivity to the subterranean environment and potential to impact groundwater, the KS will consult with MVP Construction regarding appropriate mitigation. Mitigation activities would be conducted in conjunction with recommendations from the appropriate state agency (Virginia Department of Conservation and Recreation, Karst Protection; West Virginia Department of Environmental Protection). In addition:

- As requested by Virginia DCR, The KS will contact Mr. Wil Orndorff, DCR Karst Protection (540-230-5960; Wil.Orndorff@dcr.virginia.gov) to alert DCR of a newly discovered karst feature and proposed mitigation activities. DCR may request to review the feature prior to further disturbance.
 - o If the karst feature is observed in West Virginia, it is recommended that the KS also contact Mr. Jon Bosley, Program Manager, WVDEP Stormwater Permitting (304-926-0499, ext. 1059; Jon.M.Bosley@wv.gov).

A weekly Level 1 Inspection of the stabilized or mitigated feature will be completed and documented by the KS on a Karst Feature Inspection Form (Appendix A) while construction activities (clearing and grubbing, trenching, blasting, boring or drilling) are on-going within 150 feet of the feature.

Mitigation or stabilization activities will be documented upon completion in a report prepared by the KS, to be delivered to MVP.

3.8 Management of Newly Identified Karst Features

If a suspected karst feature is intercepted during work activities, or forms within the LOD during construction activities (clearing and grubbing, trenching, blasting, boring or drilling), the KS will conduct a combined Level 1 and Level 2 Inspection of the feature.

Suspected karst features include:

- 1. Sinkhole;
- 2. Spring;
- 3. Bedrock enclosed conduit(s) or void;
- 4. Solution pocket that extend beyond visual examination range (and therefore may be open);
- 5. Soil void:
- 6. Highly fractured karst bedrock;

The KS will follow the procedural outlines listed above for Level 1 and Level 2 Inspections.

3.9 Measures to Avoid Impacts to the Karst Aquifer and Environment

The following procedures will be used during pipeline construction activities (clearing and grubbing, trenching, blasting, boring or drilling) to limit potential impact to karst features and related water resources.

- 1. Protect known and/or future mapped recharge areas of cave streams and other karst features (see Karst Hazards Assessment provided under separate cover to identify the relevant construction area where these features are located) by following relevant conservation standards, specifically those pertaining to stream and wetland crossings, erosion and sediment control, and spill prevention, containment, and control.
- 2. MVP construction activities (clearing and grubbing, trenching, blasting, boring or drilling) will be conducted in a manner that minimizes alteration of existing grade and hydrology of karst features:
 - a. In linear excavations adjacent to karst features, spoils will be stockpiled and managed upslope of the excavation, and runoff controlled according to the MVP project-specific stormwater management and ESC Plan (under separate cover).
 - b. Surface water control measures, including, but not limited to diversion (direct water flow into trench or off right-of-way areas past the area of concern), detention or collection and transportation, will be utilized to prevent construction-influenced surface water from free flowing into karst features.
 - c. Karst features will not be utilized for the disposal of water.
- 3. Blasting will be conducted in a manner that will not compromise the structural integrity or alter the karst hydrology of known or inferred subsurface karst structures. If rock is required to be hammered or blasted, the following parameters will be adhered to:
 - a. The excavation will be carefully inspected for voids or other openings, or signs of enhanced secondary porosity.
 - b. If the rock removal intercepts an open or clay-filled void, cave, or other signs of enhanced secondary porosity, see previous section of this plan for Level 1 and Level 2 Inspections.
 - c. Blasting will be conducted by a qualified blasting contractor, in accordance with the contractors written and approved blasting plan.

- d. If a track drill is used to prepare the hole(s) for the explosive charge(s) and the boring encounters an open or clay-filled void, cave, or other signs of enhanced secondary porosity, see previous section of this plan for Level 1 and Level 2 Inspections.
- 4. Comply with requirements of project Spill Prevention, Control, and Countermeasures Plan (SPCC) prepared by Contractor (under separate cover). The following general guidelines will be incorporated into the SPCC for construction practices in karst terrain:
 - a. To reduce the risk of groundwater contamination, equipment will not be parked or left idling for extended periods of time (more than 12 hours), refueled or serviced within 100 feet of any karst feature.
 - b. Equipment refueling will not be performed within flagged or marked buffer areas of streambeds, sinkholes, fissures, or areas draining into these or other karst features, except by hand-carried cans (5 gallon maximum capacity) when necessary.
 - c. Equipment servicing and maintenance areas will be sited outside of flagged or marked buffer areas of streambeds, sinkholes, fissures, or areas draining into these or other karst features.
 - d. Prevent runoff resulting from construction equipment washing operations to directly enter any karst feature by locating these operations outside of the buffer area.
 - e. Hazardous materials, chemicals, fuels, lubricating oils, and petroleum products will not be stored within 100 feet of any karst feature.
 - f. All equipment will be checked by a construction inspector daily for leaks prior to beginning work in karst areas. If any leaks are observed, or damaged or defective equipment is discovered, drip pans and other containment will be deployed immediately and the equipment removed or repaired as soon as practical.
 - g. If a reportable spill (reportable volume will be defined in the project-specific SPCC Plan) occurs within a karst feature or water body, refer to the project-specific SPCC Plan.
- 5. The intent of ESC and related Best Management Practices (BMPs) is to confine project-related disturbance to the LOD, protect sensitive karst features, and minimize erosion and enhance revegetation in those areas. In addition to ESC BMPs for standard pipeline construction, which includes specifications by regulatory agencies, additional BMPs will be implemented as specified by the KS.

- 6. Discharge of hydrostatic testing water in karst areas will be avoided if practicable. If circumstances require hydrostatic testing water to be discharged in karst areas, the KS will recommend a discharge location in consideration of the following guidelines:
 - a. Do not discharge hydrostatic testing water directly into flagged or marked buffer areas of karst features or channels or surface features that flow towards karst feature(s).
 - b. Where possible, discharge hydrostatic test water down-gradient of karst features unless onthe-ground circumstances (e.g., manmade structures, terrain, and other sensitive resources) prevent such discharge.
 - If those circumstances occur, discharge water into uplands greater than 500 feet from flagged or marked buffer areas of karst features unless on-the ground circumstances (e.g. manmade structures, terrain, other sensitive resources) prevent such discharge.
 - ii. If i.) above is not practicable, discharge water as far from flagged or marked karst features as practical and utilize additional sediment and water flow control devices to minimize effects.
 - c. Control the rate and volume of discharge to prevent land erosion, sediment mobilization and ponding of water.

Attachment 5 Mountain Valley Pipeline

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10 108 246.7 266.3 12.4 m 4,810,828 gal 226.3 37,0822107 Banishar (130110105) Upper Biackwaiter River 256.3 77,0826107 Banishar (130110105) Upper Biackwaiter River 256.3 77,0826109 gal Banishar (130110105) Upper Biackwaiter River 256.3 77,0826109 gal Banishar (130110105) Upper Biackwaiter River 11A 226.3 275.0 10.7 ml 3,430,389 gal 275.0 286.3 19.5 ml 4,701,189 gal 275.0 10.7 ml 3,430,281 gal 275.0 10			10A	235.6	246.7	0.9 mi	8,544,005 gal	•				236 8	97-38-66-12-V	3,544,005 gal	Upper Roknoke (09010101)	Mason Creek-Roanoke River	When (S-11)
10 256.3 264.5 265.5 26.5 10.7 ml 3.430,389 gal 258.5 37.0862.07 26.5 27.0862.07 27.4762.08 27.080.000 27.0	2018	10	10B	245.7	268.3	12.6 mi	4,510,562 gal	268.3	37,089210"/	Banlster (03010105)	Upper Blackwarter River	258.3	37.080210*/	966,547 gal	Barreter (03010105)	Upper Blackwater River	Tenda Creek (9-F28
11 276.0 286.3 13.5 mi 3.830,380 gal 2.80.0			100	2583	2643	еош	2,147,882 gal	283	37 089210"/ -79,900896"	Barneter (03010105)	Upper Bleckwater River	258.3	37 080210"/	2 147,882 cml	Banusher (03010105)	Upper Blackwater River	Tanda Oversk (S.F.)
116 275.0 288.3 19.3 mil 4.70e1,138.0 pil			11A	264.3	276.0	10.7 ml	3,830,389 gal	, i			-	264.3	37.048497*/	3,830,389 gal	Banister (03010105)	Upper Bleckwater River	UNT to Blockwater
6,430,261 gal 302.5 32,80 32,5	2018	£	118	275.0	266.3	13.3 ml	4,761,138 gal			i		288.3	36,937979*/	930,749 gel	Banister (03010105)	Lower Pigg River	UNIT to Pigg River
20.801.891 cal			110	288.3	303.5	15.17 mi	6,430,581 gal	903.5	38.831587"/ -70.342884"	Banleter (03010105)	Chemystone Creek-Banister	303.5	36.831597*/	669,423 gal	Benjaler (03010105)	Cherryatone Creek-Banislar	Chemelone Creek
			Actual V	Vater Requir	ed (all bold	quantifica);					Consister (consister)		-18.044084			River (0301010501)	Albert State Clear

Gross Water Required (add all moulend water); 43,239,279 gui
"Water will be filled into tent insprents in bota, then pused upstream or downstream in to smaller section upsil entire Sorand is complete.